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ABSTRACT

These teacher's materials for an eight-unit course were developed to help students develop technological literacy, career exploration, and problem-solving skills relative to the manufacturing industries. The eight units include an overview of manufacturing, manufacturing enterprises and systems, manufacturing materials and selection, manufacturing processes and selection, identifying and designing a product, product manufacturing, product marketing, and evaluation and dissolution of the enterprise. The first section is designed to teach teachers how to use the materials and includes an explanation of instructional elements, an instructional-task analysis for each unit, and a list of 30 references. The instructional elements for the units include objectives, suggested activities, references, a list of supplemental resources, information sheets, transparency masters, assignment sheets, job sheets, tests, and test answers. Some elements, such as the information sheets, include diagrams and line drawings. (CML)

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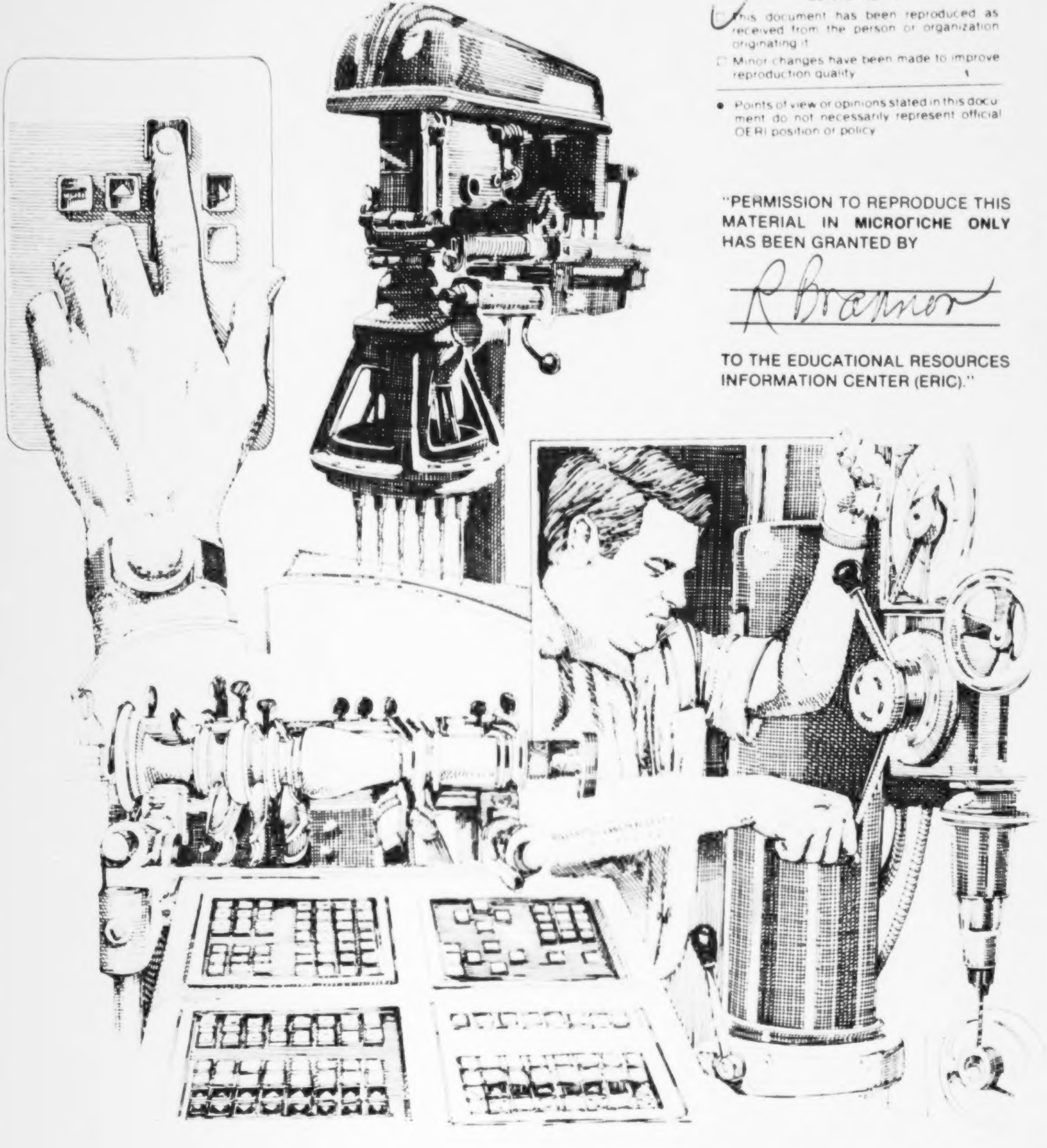

Exploring Manufacturing Technology

Mid-America Vocational Curriculum Consortium

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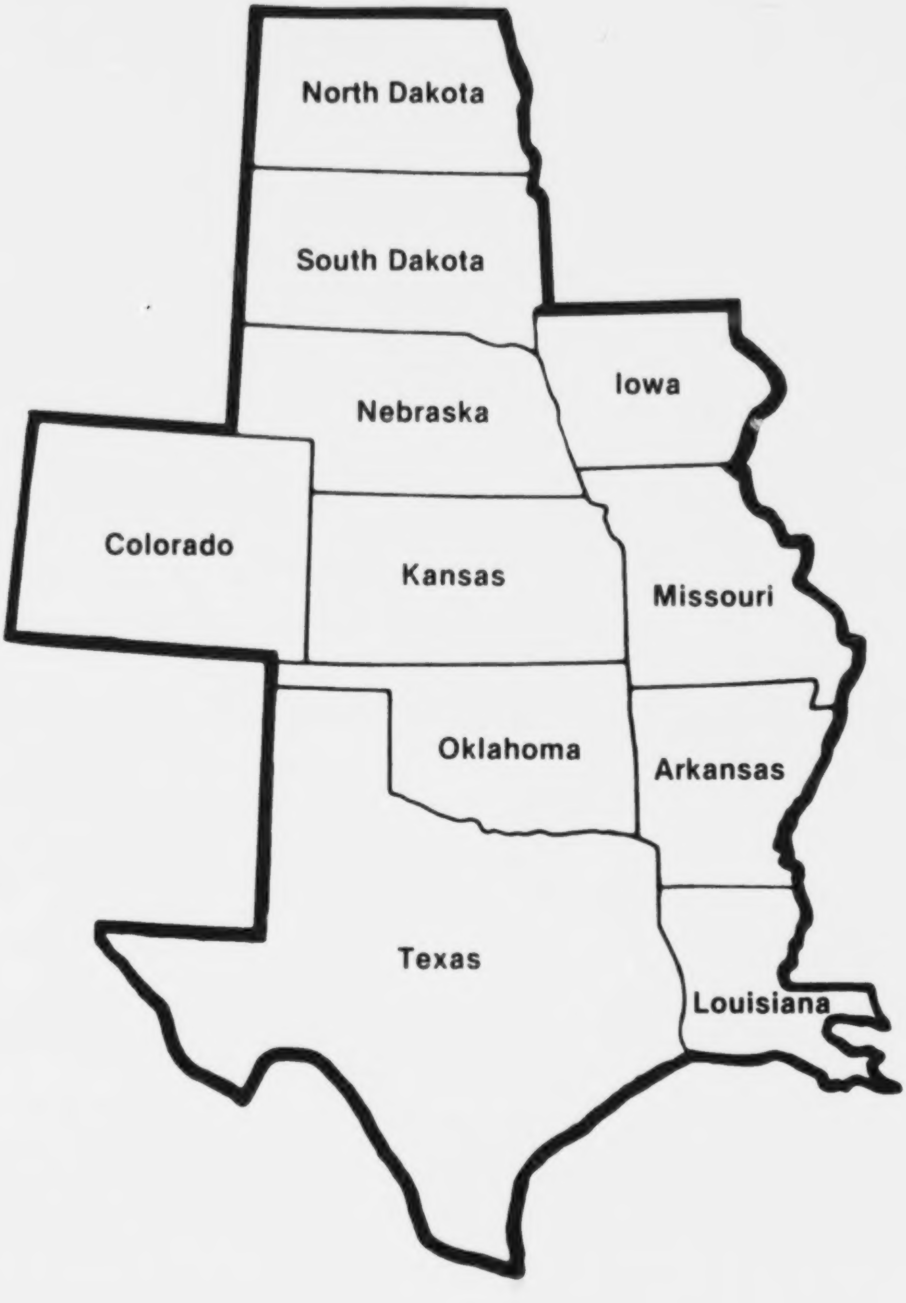
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EXPLORING MANUFACTURING TECHNOLOGY

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EXPLORING MANUFACTURING TECHNOLOGY

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FOREWORD

Technology education/industrial arts instructors are being asked to make radical changes in their programs to reflect the radical changes in our technological society. Rapid change and the current clamor for educational reform have made it evident that improvements must be made to meet the needs of students who will compete in a world quite different from the one they are experiencing in the classrooms and laboratories.

We are at the point where we need to overhaul traditional industrial arts programs and bring new and emerging technologies into the curriculum. However, the lack of instructional materials to support this new curriculum effort has made it extremely difficult. Hopefully, the new **MAVCC Technology Education Series** will aid teachers in updating and revitalizing their programs.

The series begins with *Exploring Technology Education*, Level I, which is followed by four Level II books which individually explore the technology systems of communication, construction, manufacturing, and energy, power, and transportation.

The book you are holding, *Exploring Manufacturing Technology*, is one of the Level II publications in this series. It has been developed to give students technological literacy, career exploration, and problem-solving skills dealing with the manufacturing industries.

Every effort has been made to make this publication basic, readable, and by all means, usable. Three vital parts of instruction have been intentionally omitted from the publication: motivation, personalization, and localization. These areas are left to the individual instructors who should capitalize on them. Only then will these publications become a vital part of the teaching-learning process.

Harley Schlichting, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

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USE OF THIS PUBLICATION

Instructional Units

Exploring Manufacturing Technology contains eight units of instruction. Each instructional unit includes some or all of the basic components of a unit of instruction; performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated

  1. Supplies needed
  2. Equipment needed
  3. Amount of practice needed
  4. Amount of class time needed for demonstrations

C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

EXPLORING MANUFACTURING TECHNOLOGY

INSTRUCTIONAL/TASK ANALYSIS

UNIT I: OVERVIEW OF MANUFACTURING

PRACTICAL APPLICATION: What The Student Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
	1. Terms and definitions
	2. Two major classes of industries
	3. Home handicraft system
	4. Mercantilism and the domestic cottage industries
	5. Industrial Revolution and the factory system
	6. Key developments and pioneers in mass production
	7. Terms and definitions related to modern mass production
	8. Recent advances in manufacturing
	9. Definitions of production, manufacturing, and construction
	10. Relationship between production and other technology systems
11. Complete an "Overview of Manufacturing" terminology crossword puzzle	
12. Identify a local manufacturing firm and its unique characteristics	
13. Participate in a mass production assembly activity	

PRACTICAL APPLICATION: What
The Student Should Be Able To Do
(Psychomotor)

RELATED INFORMATION: What
the Student Should Know
(Cognitive)

UNIT II: MANUFACTURING ENTERPRISES AND SYSTEMS

1. Terms and definitions
2. Characteristics of a free enterprise system
3. Items needed by a manufacturing enterprise
4. Forms of ownership of enterprises
5. Individual proprietorships
6. General partnerships
7. Corporations
8. Types of corporations
9. Characteristics of an entrepreneur
10. Steps in starting a business
11. Steps necessary to form a corporation
12. Products and services and the labor force
13. Legal requirements that affect free enterprise organizations
14. Characteristics of a license or permit
15. Three principal governmental agencies responsible for monitoring businesses
16. Types of organizational structures used in manufacturing enterprise systems
17. Components of the manufacturing system
18. Types of stock
19. Parts of a stock certificate
20. Buying, selling, and recording stock sales

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
21. Complete an entrepreneurship checklist	
22. Prepare and file articles of incorporation	
23. Draw the organizational structure of a medium-sized manufacturing company	
24. Draw the organizational structure of a classroom manufacturing activity	
25. Draw a departmental organizational chart and write a job description for one of the management positions	
26. Simulate the buying and selling of stock and record all transactions	
27. Select a stock and monitor its performance throughout the semester	

UNIT III: MANUFACTURING MATERIALS AND SELECTION

	1. Terms and definitions
	2. Three states of matter
	3. Major types of materials used in manufacturing
	4. Properties of materials
	5. Destructive and nondestructive testing of industrial materials
	6. Major factors for material selection
	7. Types of wood and their characteristics
	8. Ways to identify various woods
	9. Properties and characteristics of wood
	10. Advantages of woods

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
	11. Forms of wood materials and how they are sold
	12. Types of metals
	13. Metals identification and designation
	14. Properties of metal
	15. Forms of metal materials and how they are sold
	16. Types of plastics
	17. Nondestructive and destructive tests for plastics identification
	18. Properties of plastics
	19. Forms of plastics materials
	20. Types of earth materials
	21. Major parts of a composite
	22. History of composites
	23. Types of composite structures
	24. Advantages of composites
	25. Other manufacturing materials in common use
26. Complete crossword puzzle of manufacturing materials terminology	
27. Test materials and products	
28. Select and identify materials used for manufacturing products	

PRACTICAL APPLICATION: What
The Student Should Be Able To Do
(Psychomotor)

RELATED INFORMATION: What
the Student Should Know
(Cognitive)

UNIT IV: MANUFACTURING PROCESSES AND SELECTION

1. Terms and definitions
2. Stages in material processing
3. Major processes for acquiring raw materials
4. Primary processes for producing industrial materials
5. Secondary processes
6. Elements of separating
7. Separating processes
8. Elements of the forming process
9. Forming processes
10. Elements of casting and molding
11. Casting and molding processes
12. Considerations for determining conditioning process
13. Reasons for conditioning materials
14. Types of conditioning processes
15. Typical conditioning methods for various materials
16. Elements in assembling processes
17. Types of joints
18. Relationship between finishing and the other secondary processes
19. Elements in finishing
20. Types of metallic coatings and platings
21. General safety rules for manufacturing

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
22. Complete a crossword puzzle of "manufacturing processes" terminology	
23. Identify products which have been formed	
24. Identify products which have been cast or molded	
25. Survey the school laboratory for secondary processes and associate them with the major industrial material	
26. Complete a separating process analysis chart	
27. Complete a forming process analysis chart	
28. Complete a casting and molding process analysis chart	
29. Complete a conditioning process analysis chart	
30. Complete an assembling process analysis chart	
31. Complete a finishing process analysis chart	
32. Cut steel and drop forge a screwdriver blade	
33. Layout, grind screwdriver blade to shape, and bend	
34. Perform heat treatment, hardness testing, and bead blasting of screwdriver	
35. Test screwdriver blade using liquid penetrant testing	
36. Finish screwdriver blade using "electroless electroplate"	
37. Make a WEP handle for screwdriver	
38. Trim the handle and finish the screwdriver	

PRACTICAL APPLICATION: What
The Student Should Be Able To Do
(Psychomotor)

RELATED INFORMATION: What
the Student Should Know
(Cognitive)

UNIT V: IDENTIFYING AND DESIGNING A PRODUCT

1. Terms and definitions
2. Major functions of research and development
3. Types of research
4. Processes of research and development
5. Main types of professionals involved in research and development
6. Functions of development
7. Product development
8. Approaches to developing new products
9. Sources of product ideas
10. Major factors considered in designing a product
11. Main elements in a product profile
12. Steps in product development
13. Market research and development
14. Process development
15. Definition and purpose of product engineering
16. Areas of product engineering
17. Criteria that guide product selection
18. Design a product that can be mass produced by your class
19. Complete a product profile for the prototype
20. Conduct a market survey for the prototype
21. Complete a bill of materials for the prototype

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)

RELATED INFORMATION: What the Student Should Know (Cognitive)

UNIT VI: PRODUCT MANUFACTURING

1. Terms and definitions
2. Factors that determine how a manufacturing enterprise is organized
3. Types of manufacturing production methods
4. Common types of mass production
5. Key principles of mass production
6. Components needed for production
7. Responsibilities of industrial engineering
8. Methods for selection and sequence of manufacturing operations
9. Considerations in tooling up
10. Major objectives of tooling
11. Types of tooling required for interchangeability of parts.
12. Considerations in plant layout
13. Basic types of plant layout
14. Characteristics of a good material-handling system
15. Types of material-handling equipment
16. Actions monitored by production planning and control
17. Major functions of quality control
18. Steps involved in inspection
19. Steps in obtaining materials and equipment for production
20. Steps in obtaining labor for production
21. Attributes an employer looks for in an employee
22. Contents of a labor contract

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)

RELATED INFORMATION: What the Student Should Know (Cognitive)

23. Complete a flow process chart
24. Develop an operation process chart
25. Complete an operation analysis sheet
26. Design a jig or fixture
27. Make a plant layout and develop a flow diagram
28. Design an inspection gage
29. Complete a job description
30. Complete a job application form

UNIT VII: PRODUCT MARKETING

1. Terms and definitions
2. Major activities of marketing
3. Elements of a marketing plan
4. Purposes of market research
5. Reasons for doing a market survey
6. Methods used to conduct market research
7. Stages in a product's life cycle
8. Functions of advertising
9. Steps in preparing an advertisement
10. Principal elements of an advertisement
11. Media used for advertisements
12. Items in a profile of potential customers
13. Functions of a package

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
	14. Types of packaging and packaging processes
	15. Considerations in package selection
	16. Design considerations for packages
	17. Items include in or on a package
	18. Inventory and inventory control
	19. Categories of inventory
	20. Status of products prior to distribution
	21. Automated systems for storage, retrieval, and delivery
	22. Important elements of sales planning
	23. Information a salesperson must know
	24. Parts of a sales system
	25. Steps in a sales presentation
	26. Parts of a sales order form
	27. Major methods of distributing goods
	28. Ways to distribute and ship products
	29. Stages of product use cycle
30. Design an advertisement to promote and sell your product	
31. Design a package for your product	

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)

UNIT VIII: EVALUATION AND DISSOLUTION OF THE ENTERPRISE

PRACTICAL APPLICATION: What The Student Should Be Able To Do (Psychomotor)	RELATED INFORMATION: What the Student Should Know (Cognitive)
	1. Terms and definitions
	2. Characteristics of successful companies
	3. Characteristics of successful people
	4. Records and reports for calculating a company's profit and loss
	5. Definition of dissolution
	6. Types of dissolution
	7. Voluntary dissolution
	8. Involuntary dissolution
	9. Steps in dissolving a corporation
	10. Evaluating a student enterprise and the personnel
11. Complete a "Corporation Dissolution" terminology crossword puzzle	
12. Dissolve the simulated enterprise and complete Articles of Dissolution	
13. Evaluate your enterprise and yourself	

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OVERVIEW OF MANUFACTURING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe historical events and developments contributing to modern manufacturing. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to an overview of manufacturing with the correct definitions.
2. Distinguish between the two major classes of industries.
3. Select true statements concerning the home handicraft system.
4. Complete statements describing mercantilism and the domestic cottage industries.
5. Complete statements concerning the Industrial Revolution and the factory system.
6. Match key developments and pioneers in mass production with the correct descriptions.
7. Match terms related to modern mass production with the correct definitions.
8. Match recent advances in manufacturing with the correct descriptions.
9. Differentiate between production, manufacturing, and construction.
10. Complete statements concerning the relationship between production and other technology systems.

OBJECTIVE SHEET

11. Complete an "Overview of Manufacturing" terminology crossword puzzle. (Assignment Sheet #1)

12. Identify a local manufacturing firm and its unique characteristics. (Assignment Sheet #2)

13. Participate in a mass production assembly activity. (Assignment Sheet #3)

OVERVIEW OF MANUFACTURING
UNIT I

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

(NOTE: You may also wish to provide your students with the word list that corresponds to the crossword puzzle on Assignment Sheet #1. This list is included with the answers to that assignment sheet.)

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Tour local manufacturing plants. An alternative to this would be to videotape the operation of a plant (at a convenient time for the plant) and then playback the videotape for the class. This will save class time.

2. Show films on manufacturing plants and various manufacturing systems. Two films are listed in the Suggested Supplemental Resources.

3. Discuss the good and bad features of the factory system.

4. Discuss the need for productivity and how it is measured in manufacturing businesses.

5. Discuss career opportunities in manufacturing, the different types of jobs, and their educational requirements.

6. Discuss your ideas about what manufacturing may be like in the future—decrease in the number of workers, increase in productivity, new processes and products, etc.

7. Tell students that they will be forming a company that will mass produce a product. The organization will select the product.

8. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

SUGGESTED ACTIVITIES

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

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B. Burden, W. Wilson. *66 Centuries of Measurement.* Dayton, OH: The Sheffield Corporation, 1960.

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F. Wright, R. Thomas and Len Sterry. *Industry and Technology Education: A Guide for Curriculum Designers, Implementors, and Teachers.* Lansing, Illinois: Technical Foundation of America, no date.

SUGGESTED SUPPLEMENTAL RESOURCES

A. *Factory of the Future*, #882 (sound filmstrip or videocassette)

B. *Manufacturing Systems Explained*, #890 (sound filmstrip or videocassette)

Supplemental resources A and B are available from:

Bergwall Productions, Inc.
106 Charles Lindbergh Blvd.
Uniondale, NY 11553-3695
Telephone 800-645-3565 or 516-222-1111 in New York

OVERVIEW OF MANUFACTURING
UNIT I

INFORMATION SHEET

I. **Terms and definitions** (Assignment Sheet #1)

A. Manufacturing — Making products to be sold for profit (Transparency 1)

(NOTE: The important words in this definition are *making, products,* and *profit*. These words distinguish manufacturing from other activities.)

B. Factories — Buildings where goods are manufactured

C. Productivity — Making products quickly and accurately

D. Industries — Businesses which produce goods or services

II. **Major classes of industries** (Assignment Sheet #2)

A. Goods industries

1. Agriculture, forestry, and fisheries
2. Mining
3. Construction
4. Manufacturing

B. Service industries

1. Wholesale and retail trade
2. Finance, insurance, and real estate
3. Transportation
4. Communications and public utilities
5. Health care
6. Government

(NOTE: More people are employed in service industries than in goods industries.)

III. **Home handicraft system** (Transparency 2)

A. When man developed tools, he started making things such as weapons, clothing, pottery, and other utensils used in the home.

INFORMATION SHEET

B. When he became skilled enough, he made more goods than he could use in his home. Now he could sell or barter the excess for other goods that he needed. This is when real manufacturing started. He was now *making* a *product* for *profit*.

C. Features of this system included

1. Worker was independent.
2. He worked at home whenever he chose.
3. He owned his own tools.

IV. **Mercantilism and the domestic cottage industries system** (Transparency 2)

A. These systems thrived during the Middle Ages from 1200 to 1700 A.D. and evolved chiefly around the textile industry.

B. The cottage industry system consisted of the following:

1. A merchant bought large supplies of wool, cotton, or silk stock.
2. He distributed this stock to numerous households.
3. The households would spin, dye, and weave the cloth into various textile and tapestry products.
4. The merchant collected and sold the products, paid the households for their work, and supplied them with more stock.

C. The good features of this system included:

1. The craftsman worked at home.
2. He was not totally dependent upon the merchant's business; he could do other work when the textile business was slow.
3. He had the help of other members of his household including his wife, children, and other relatives.

D. The bad features of this system included:

1. The craftsman did not usually own his own tools; these were supplied by the merchant.
2. Rare materials tended to disappear, or not produce the quantity of products expected by the merchants.
3. Merchants could refuse to pay the expected amount for products, and the craftsmen had little recourse.

INFORMATION SHEET

V. **The Industrial Revolution and the factory system** (Transparency 2)

A. The Industrial Revolution from about 1750 to 1850 A.D. ended the cottage industry (also called the "putting out" system) as a major system of manufacturing. There were several reasons this occurred.

1. Machines were invented that were too large and too expensive to place in households.

   Examples: The Spinning Jenny which replaced the spinning wheel, the Flying Shuttle which was a semiautomatic loom for weaving cloth, and the Cotton Gin which provided an easier and quicker way of removing the seeds from raw cotton.

2. New sources of power were found and machines had to be located near the sources of power.

   a. The waterwheel had long been used in flour milling. The water frame, invented in the 1700s, used the waterwheel to power the flying shuttle. This required a location near a stream.

   b. Coal became an important fuel in the iron industry and for powering the steam engines. Coal is difficult to transport; hence, industries using it were normally located close to coal mines.

B. Characteristics of the factory system (Transparency 3)

1. All the machines required to produce a product were housed in one building near a source of power.

2. Large industrial cities grew up around the factories as workers built homes as close as possible to the factories were they worked.

3. Large cities became markets for the products made in the factories.

4. The factory system thrived because:

   a. When all operations were centralized in one location, machines and workers could be managed and organized more efficiently.

   b. The products were produced quicker and cheaper, which is what the consumer wanted.

INFORMATION SHEET

VI. **Key developments and pioneers in mass production**

A. Interchangeability of parts — In 1800, Eli Whitney introduced the use of interchangeable parts to mass produce weapons. He is called the "Father of Mass Production."

B. Power machining — James Watt improved the steam engine, which made it possible to efficiently power equipment.

C. Precision measuring tools — These were tools, such as the micrometer, which enabled manufacturers to produce the very accurate parts necessary for interchangeability.

(NOTE: The hand micrometer was first patented in 1848.)

D. Assembly line — Introduced by Henry Ford in the early 1900's to allow making as many parts as possible in the shortest time and for the lowest cost.

VII. **Main features of modern mass production** (Assignment Sheet #3)

(NOTE: Mass production is a method of organizing manufacturing processes to obtain high output rates.)

A. **Efficient organization or management**

1. This came from the Industrial Revolution and refers to the centralizing of all operations in one locality.

2. Efficient management was developed to find quick solutions to the production bottlenecks which caused loss of time and money.

B. **Mechanization and automation of operations** — Letting machines do as much of the work as possible to increase productivity.

(NOTE: Today computer automation ensures uniform quality.)

C. **Assembly line** — Automatic conveyance of a product from one worker to the next until assembly is complete.

D. **Division of labor** — Dividing jobs into functions to increase efficiency.

E. **Interchangeability of parts** — The making of parts that will fit all machines that use them.

VIII. **Recent advances in manufacturing**

A. Numerical control (NC) — 1948 — Developed by John Parsons for controlling machines and equipment by the direct insertion of numerical data (NC tape)

B. Industrial robot (IR) — 1961 — First actual IR machine to perform tasks that would otherwise be done by human labor

INFORMATION SHEET

C. Computer-aided drafting (CAD) — 1963 — Computer assists in the creation, storage, modification, and plotting of a technical drawing

D. Direct numerical control (DNC) — 1968 — Eliminates tape reader step; programmed instructions go directly from computer memory to the machine tool

E. Computer-aided manufacturing (CAM) — 1970 — Broad term for all manufacturing processes that are aided by computers

F. Computer numerical control (CNC) — 1976 — Machine operation controlled by computer that uses feedback to check operations and adjust if necessary

G. CAD/CAM system — 1980's — Links engineering and design with production

H. Computer-integrated manufacturing (CIM) — Business and production aspects of a manufacturing facility that are controlled by a computer

I. Flexible manufacturing system (FMS) — Manufacturing process in which tools and machines can be reprogrammed to produce different parts; ideal to produce small quantities of different parts, continuously

J. Just-in-time (JIT) — Raw materials and other required parts arrive at the factory just before they are needed in the assembly process; keeps inventory low

(NOTE: Emerging manufacturing processes, such as the use of lasers, have made many changes in the manufacturing industry.)

IX. **Production, manufacturing, and construction** (Transparency 4)

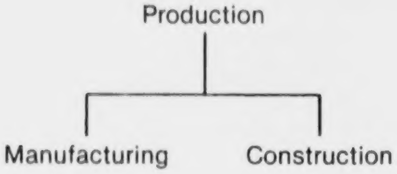
A. *Production* is defined as changing the form of materials to make them usable.

B. It can be divided into two major types of activities.

   1. *Manufacturing:* Production carried out at one site and used at another.

   2. *Construction:* Production carried out and utilized at the same site.

FIGURE 1



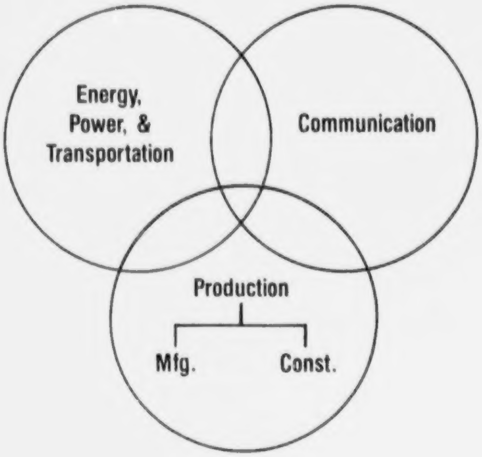
INFORMATION SHEET

X. Relationship between production and other technology systems

A. Energy, power, and transportation technology includes the movement of materials, people, and products as well as generation and utilization of energy to aid in the production process. Without energy, power, and transportation, production could not occur.

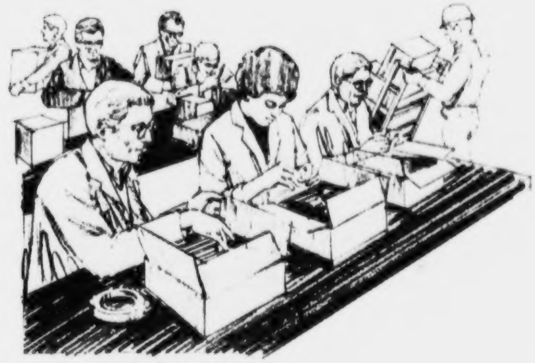
B. Communication technology involves the movement of messages and information which are essential to the production operation. Without communication, production could not occur.

FIGURE 2

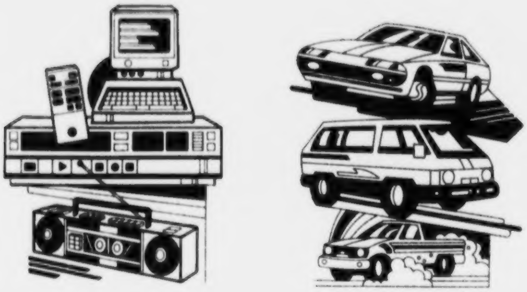

Energy,
Power, &
Transportation
Communication
Production
Mfg.
Const.

Manufacturing (Key Words)

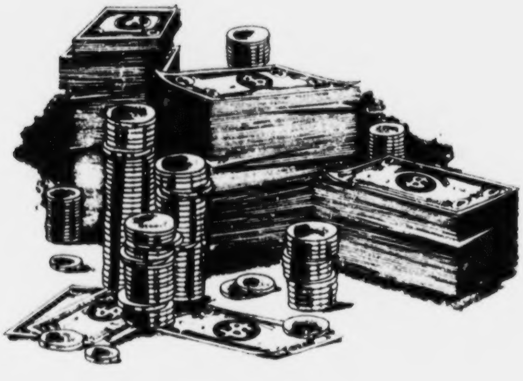
Making



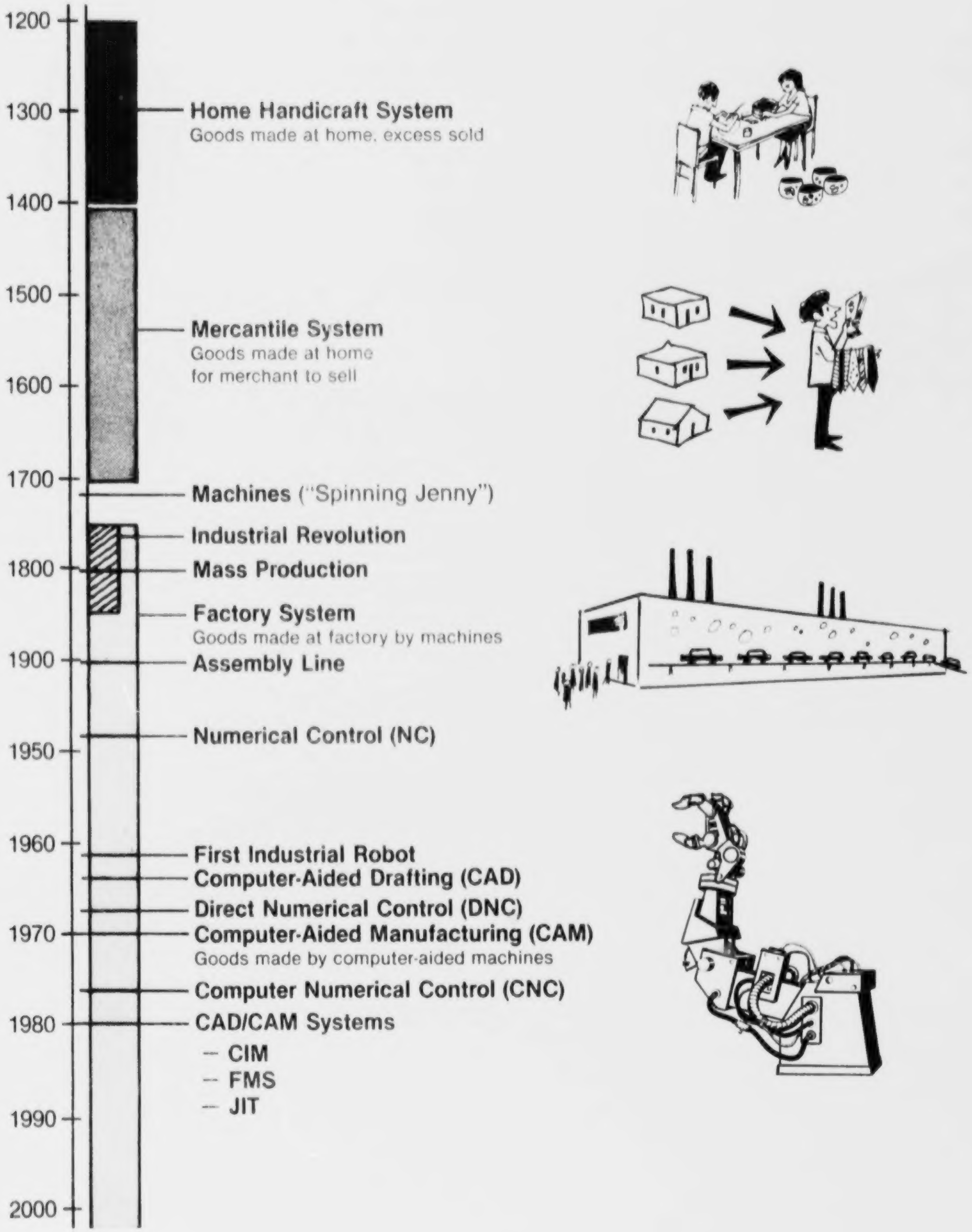
Products



Profit

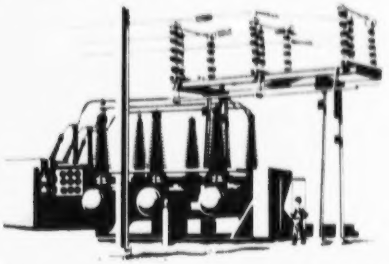


Major Milestones in the Development of Manufacturing

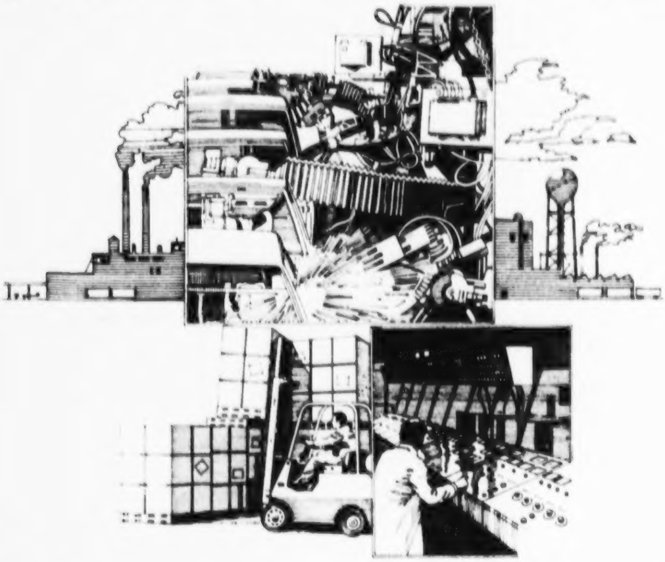


Characteristics of the Factory System

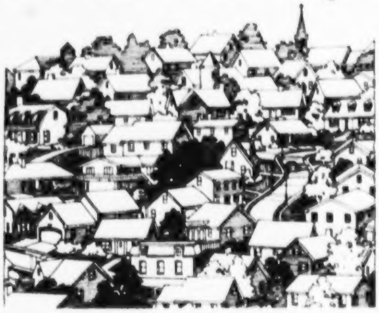
1. Source of Power Nearby



2. All Equipment and Machines in One Building



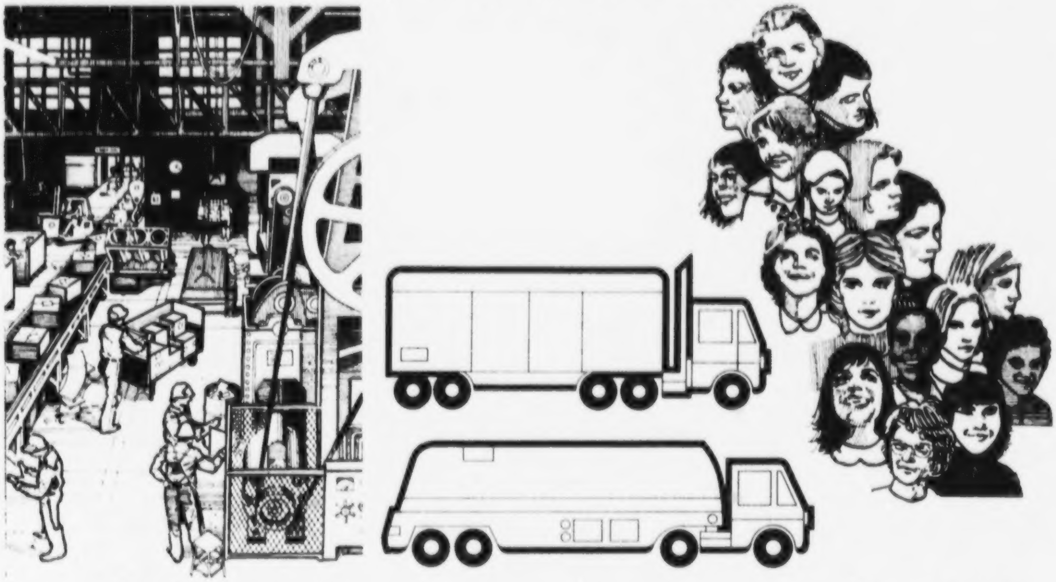
3. Factories Located Near Population Centers



Production

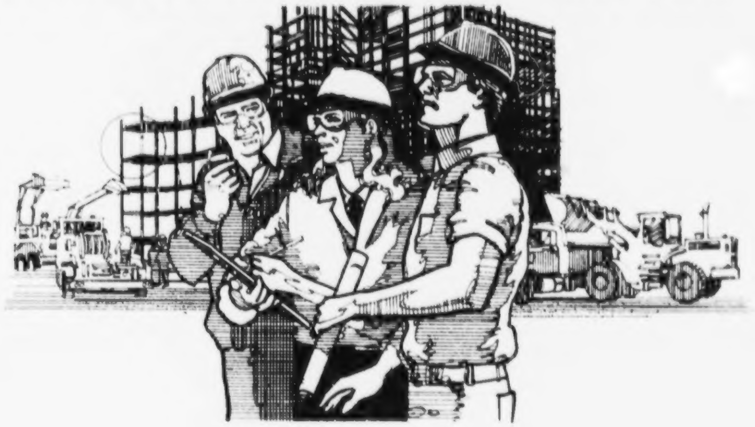
Production — Changes the form of materials to make them more usable.

Manufacturing — A form of production where the production is carried out at one place and the items produced are transported to the user.



Products to Consumers

Construction — A form of production where the product is built and used at the same site.



OVERVIEW OF MANUFACTURING
UNIT I

ASSIGNMENT SHEET #1 — COMPLETE AN "OVERVIEW OF MANUFACTURING" TERMINOLOGY CROSSWORD PUZZLE

NAME ______________________________ SCORE ________________________

Directions: This crossword puzzle reviews some of the terminology discussed in this unit. Carefully review the clues and fill in the appropriate blanks. This activity should be done in *pencil*.

Evaluation: There are 25 answers to be completed; therefore, each correct answer is worth four points. The instructor will provide the grading scale for this assignment. A minimum score of 80% is required for this activity.

Correct	Score
25	100
24	96
23	92
22	88
21	84
20	80

ASSIGNMENT SHEET #1

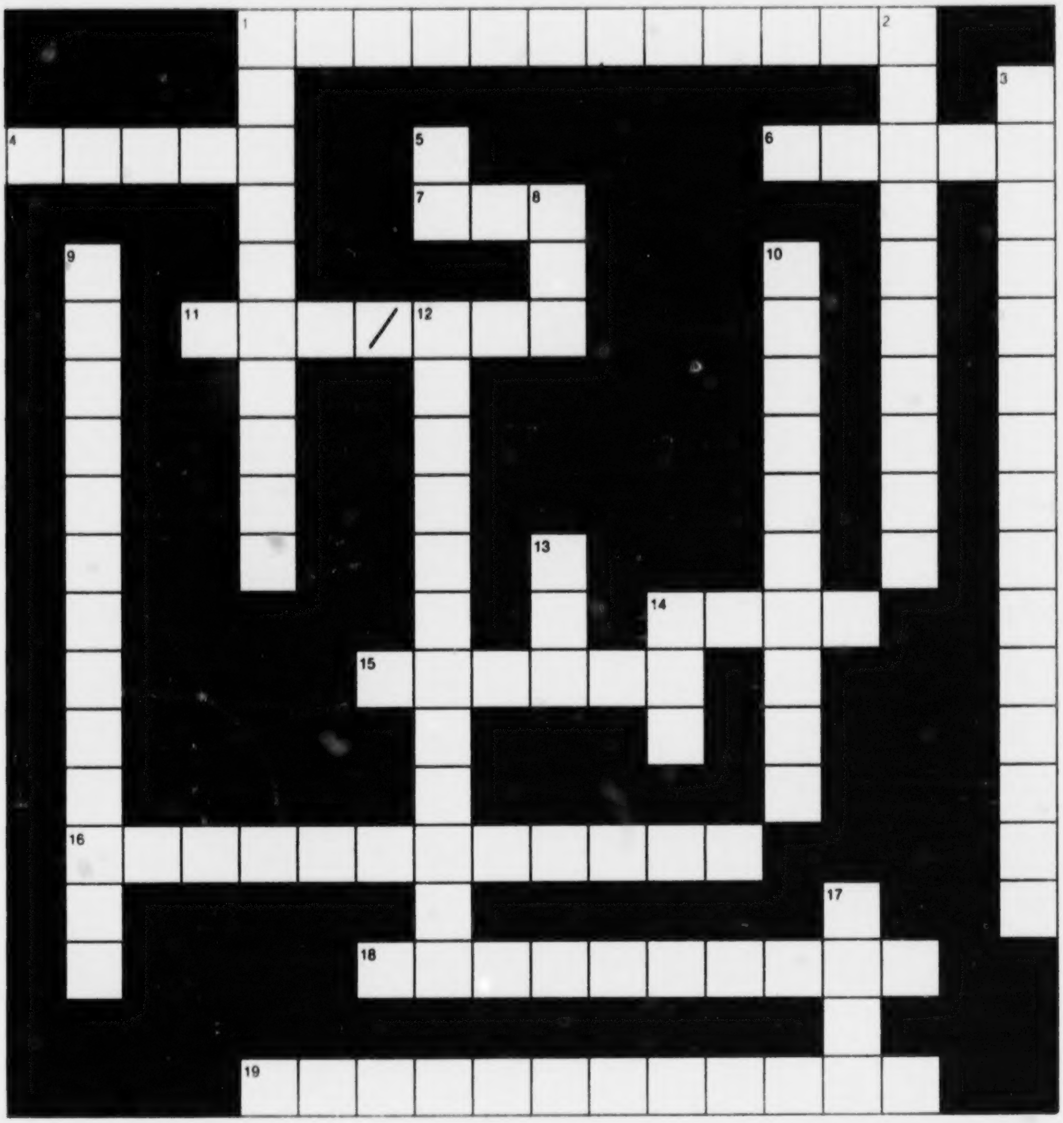
ACROSS CLUES

1. Automatic conveyance of a product from one worker to the next until assembly is complete
4. Machines that perform tasks that would otherwise be done by people
6. An organized group of workers
7. Machine operation controlled by a computer that uses feedback to check operations and adjust
11. Links engineering and design with production
14. Developed the assembly line in the early 1900's
15. Oldest type of manufacturing; craftsman produces individual or limited quantity of items
16. Used when the volume of products is too low for continuous manufacturing
18. The revolution that ended the cottage industry is referred to as the ______________ revolution
19. Products made at home then sold by a merchant is called ______________

DOWN CLUES

1. A way of making a machine, process, or system operate without constant human control
2. Introduced the use of interchangeable parts to industry
3. The making of parts that will fit all of the machines that use them
5. The control of machines or processes by using command instructions coded numerically
8. Aspects of a manufacturing facility that are controlled by a computer
9. Production carried out at one site and then used at another
10. To sell surplus goods made at home is called the home ______________ system
12. Production carried out and utilized at the same site
13. Designed to reduce inventory; to have materials arrive at each operation just prior to use
14. Manufacturing process in which tools and machines can be programmed to produce parts
17. The manufacturing of large quantities of identical parts or products; ______________ production

ASSIGNMENT SHEET #1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OVERVIEW OF MANUFACTURING
UNIT I

ASSIGNMENT SHEET #2 — IDENTIFY A LOCAL MANUFACTURING FIRM AND ITS UNIQUE CHARACTERISTICS

NAME ____________________ SCORE ____________________

Directions: Select a manufacturing firm in your community. Interview a person within the firm to gather the information needed to complete the worksheet provided.

Evaluation: You will be evaluated on the basis of correct completion of this form. Should you have any questions, ask you instructor.

1. Name of firm: ____________________
2. Name of owner: ____________________
3. Name of president: ____________________
4. Number of employees: ____________________
5. Years in operation: __________ Date started: __________
6. Function of the firm: ____________________

   ____

   ____

7. Type of production (e.g. custom): ____________________

   ____

8. Product(s) description(s): ____________________

   ____

9. Does the firm sell the product(s) it makes? ____________________

   If no, why not? ____________________

   ____

10. What are some of the unique characteristics of the firm? (FMS, JIT, CNC, NC, robots, location to materials or distribution) ____________________

    ____

OVERVIEW OF MANUFACTURING
UNIT I

ASSIGNMENT SHEET #3 — PARTICIPATE IN A MASS PRODUCTION ASSEMBLY ACTIVITY

NAME ______________________________ SCORE ______________________

Materials needed:

1. 45-60 inexpensive ball-point pens (click-type) — three for each student
2. Stop watch or timer
3. Assignment Sheet #3 Questions

(NOTE: Read all directions before beginning this assignment.)

Directions: Your instructor will divide the class into groups (preferably 5-10), and issue each student three (3) pens. Each group is to do the following:

1. Disassemble all ball-point pens.
2. Name the group.
3. Plan how the group will reassemble the pens. You will have five minutes to do this.
4. After the planning time, your instructor will start the competition and time each group.
5. Upon completion, record your group's time and then examine the "products" to determine the rate of rejection.
6. Discuss within your group how improvements could have been made to improve your group's time.
7. Complete the worksheet provided with the information you have acquired by participating in a mass production operation.

ASSIGNMENT SHEET #3 QUESTIONS

NAME ______________________ SCORE ____________________

Directions: Upon completion of the Mass Production Activity, answer the following questions.

Evaluation: You will be graded on the correct completeness and neatness of this form.

1. What is the name of your group?

   ____

2. How long did it take your group to complete the task?

   __________ minutes __________seconds

3. How did your group perform compared to the other group(s)?

   ____

4. Why was your group faster or slower than the other group(s)?

   ____

   ____

5. How could your group have improved its time? ____________________

   ____

6. Sketch and describe your group's method of assembly of the pens. (Below and on back)

   ____

   ____

   ____

   ____

   ____

   ____

   ____

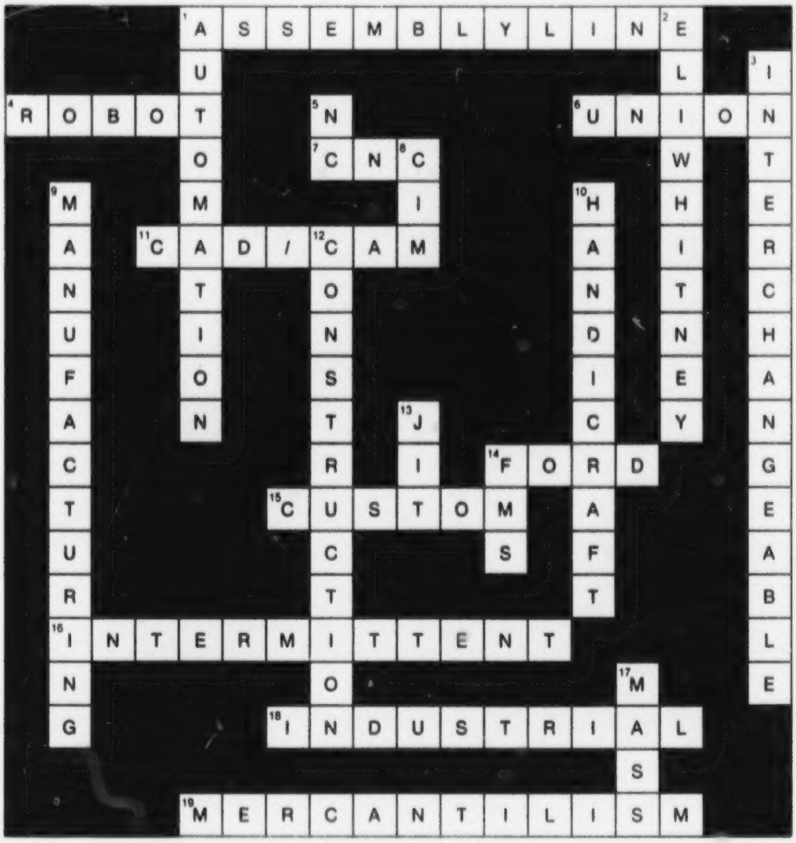
   ____

   ____

OVERVIEW OF MANUFACTURING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


1 ASSEMBLYLINE
1 AUTOMATION
2 ELIWHITNEY
3 INTERCHANGEABLE
4 ROBOT
5 NC
6 UNION
7 CNC
8 CIM
9 MANUFACTURING
10 HANDICRAFT
11 CAD/CAM
12 CONSTRUCTION
13 JIT
14 FORD
14 FMS
15 CUSTOM
16 INTERMITTENT
17 MASS
18 INDUSTRIAL
19 MERCANTILISM

WORD LIST:

- Assemblyline
- Automation
- CAD/CAM
- CIM
- CNC
- Construction
- Custom
- Eli Whitney
- FMS
- Ford
- Handicraft
- Intermittent
- Industrial
- Interchangeable
- JIT
- Manufacturing
- Mass
- Mercantilism
- NC
- Robot
- Union

Assignment Sheets #2 - #3 — Evaluated to the satisfaction of the instructor

OVERVIEW OF MANUFACTURING
UNIT I

TEST

NAME ____________________________ SCORE ______________________

1. Match the terms on the right with the correct definitions.

_____a.	Making products to be sold for profit	1. Factories
_____b.	Making products quickly and accurately	2. Industries
_____c.	Buildings where goods are manufactured	3. Manufacturing
_____d.	Businesses which produce goods or services	4. Construction
		5. Productivity

2. Distinguish between the two major classes of industries by placing a "G" next to the goods industries and an "S" next to the service industries.

_____a. Transportation

_____b. Manufacturing

_____c. Health care

_____d. Retail trade

_____e. Construction

_____f. Mining

_____g. Finance

_____h. Government

_____i. Agriculture

_____j. Communications

TEST

3. Select true statements concerning the home handicraft system by marking "T" for true and "O" for false statements.

_____a. Worker had to work specific hours

_____b. Worker owned his own tools

_____c. Worker was independent

_____d. Worker worked at home whenever he chose

_____e. Worker was responsible for reasonable output

4. Complete the following statements describing mercantilism and domestic cottage industries by circling the correct words.

   a. With the cottage industries system a (**consumer, merchant**) bought large supplies of raw material, provided it to a household, and upon production of a certain product, collected and sold the products.

   b. A good feature of the cottage industries system was that the craftsman worked (**at home, in factories**).

   c. The cottage industries system evolved chiefly around the (**agriculture, textiles**) industry.

   d. The cottage industry system began to diminish and disappear around (**1550, 1750**) A.D.

5. Complete the following statements concerning the Industrial Revolution and the factory system by circling the correct word(s).

   a. The Industrial Revolution was brought about by the invention of (**hand tools, machines**) which were used in (**factories, homes**).

   b. The Industrial Revolution caused cities to (**grow, decline**).

6. Match the key developments and pioneers in mass production on the right with the correct descriptions.

_____a. Enabled manufacturers to produce very accurate parts necessary for interchangeability

_____b. Introduced the use of interchangeable parts to mass produce weapons

_____c. Enabled the making of as many parts as possible in the shortest time and for the lowest cost; introduced by Henry Ford

_____d. Improved the steam engine

1. James Watt
2. Assembly line
3. Precision measuring tools
4. John Parsons
5. Eli Whitney

TEST

7. Match the terms related to modern mass production on the right with the correct definitions.

_____a. Refers to the centralization of all operations in one locality

_____b. Letting machines do as much of the work as possible to increase productivity

_____c. Automatic conveyance of a product from one worker to the next until assembly is complete

_____d. Dividing jobs into functions to increase efficiency

_____e. The making of parts that will fit all machines that use them

1. The assembly line
2. Just-in-time
3. Efficient organization or management
4. Division of labor
5. Mechanization and automation of operations
6. Precision measuring
7. Interchangeability of parts

8. Match recent advances in manufacturing listed on the right with the correct descriptions.

_____a. Machine that performs tasks that would otherwise be done by human labor; first one in 1961

_____b. Broad term for all manufacturing processes that are aided by computers

_____c. Controlling machines and equipment by the direct insertion of numerical data (tape); developed by John Parsons in 1948

_____d. Eliminates tape reader step; programmed instructions go directly from computer memory to the machine tool

_____e. Computer assists in the creation, storage, modification, and plotting of a technical drawing

_____f. Manufacturing process in which tools and machines can be reprogrammed to produce different parts; ideal to produce small quantities, continuously

_____g. Business and production aspects of a manufacturing facility that are controlled by a computer

_____h. Raw materials and other required parts arrive at the factory just before they are needed in the assembly process; keeps inventory low

1. CAD
2. CAD/CAM
3. CAM
4. CIM
5. CNC
6. DNC
7. FMS
8. IR
9. JIT
10. NC

TEST

9. Differentiate between production, manufacturing, and construction by placing the following letters next to the correct descriptions.

   P — Production
   M — Manufacturing
   C — Construction

   _____a. Production carried out and utilized at the same site

   _____b. Changing the form of materials to make them usable

   _____c. Production carried out at one site and used at another

10. Complete statements concerning the relationship between production and other technology systems by circling the correct words.

    a. Energy, power, and (**transportation, communication**) technology includes the movement of materials, people, and products as well as generation and utilization of energy to aid in the production process.

    b. Without energy, power, and transportation, (**technology, production**) could not occur.

    c. (**Communication, Transportation**) involves the movement of messages and information which are essential to the production operation.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

11. Complete an "Overview of Manufacturing" terminology crossword puzzle. (Assignment Sheet #1)

12. Identify a local manufacturing firm and its unique characteristics. (Assignment Sheet #2)

13. Participate in a mass production assembly activity. (Assignment Sheet #3)

OVERVIEW OF MANUFACTURING
UNIT I

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 1
   d. 2

2. a. S
   b. G
   c. S
   d. S
   e. G
   f. G
   g. S
   h. S
   i. G
   j. S

3. a. O
   b. T
   c. T
   d. T
   e. O

4. a. Merchant
   b. At home
   c. Textile
   d. 1750

5. a. Machines, factories
   b. Grow

6. a. 3
   b. 5
   c. 2
   d. 1

7. a. 3
   b. 5
   c. 1
   d. 4
   e. 7

8. a. 8
   b. 3
   c. 10
   d. 6
   e. 1
   f. 7
   g. 4
   h. 9

ANSWERS TO TEST

9. a. C
   b. P
   c. M

10. a. Transportation
    b. Production
    c. Communication

11.-13. Evaluated to the satisfaction of the instructor

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe a manufacturing enterprise and discuss the various systems that comprise this entity. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to manufacturing enterprises and systems with the correct definitions.
2. Select from a list the characteristics of a free enterprise system.
3. Match the items needed by a manufacturing enterprise with the correct descriptions.
4. Distinguish between the forms of ownership of enterprises.
5. Complete statements concerning individual proprietorships.
6. Complete statements concerning general partnerships.
7. Select true statements concerning corporations.
8. Match types of corporations with the correct descriptions.
9. Select from a list the characteristics of an entrepreneur.
10. Arrange in order the steps in starting a business.

OBJECTIVE SHEET

11. Arrange in order the steps necessary to form a corporation.
12. Select true statements concerning products and services and the labor force.
13. Select true statements concerning legal requirements that affect free enterprise organizations.
14. Select from a list characteristics of a license or permit.
15. Select from a list the three principal governmental agencies responsible for monitoring businesses.
16. Match the types of organizational structures used in manufacturing enterprise systems with their diagrams.
17. Match the components of the manufacturing system with the correct descriptions.
18. Complete statements concerning types of stock.
19. Label parts of a stock certificate.
20. Complete statements concerning the buying, selling, and recording of stock sales.
21. Complete an entrepreneurship checklist. (Assignment Sheet #1)
22. Prepare and file articles of incorporation. (Assignment Sheet #2)
23. Draw the organizational structure of a medium-sized manufacturing company. (Assignment Sheet #3)
24. Draw the organizational structure of a classroom manufacturing activity. (Assignment Sheet #4)
25. Draw a departmental organizational chart and write a job description for one of the management positions. (Assignment Sheet #5)
26. Simulate the buying and selling of stock and record all transactions. (Assignment Sheet #6)
27. Select a stock and monitor its performance throughout the semester. (Assignment Sheet #7)

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. The assignment sheets should be used to help identify the organizational structure the class will use.
2. Plan to finalize this structure before the completion of this unit.
3. Hold an election to identify a president.
4. Once the president has been selected, begin interviews for other top positions.
5. Provide opportunity for students to do a role-playing activity which addresses various manufacturing careers.
6. Play a game such as Big Manufacturer, formerly used in IACP Manufacturing program.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

A. Bame, E. Allen and Paul Cummings. *Exploring Technology.* Worcester, MA: Davis Publications, Inc., 1980.

B. Hanson, Garth A. *Entrepreneurship: A Career Alternative.* Columbus, OH: The National Center for Research in Vocational Education, 1984.

C. Heiner, Carl W. and Wayne R. Hendrix. *People Create Technology.* Worcester, MA: Davis Publications, Inc., 1980.

D. *Industrial Education: Materials & Processes,* C.B.I.E. Project, Kansas State Department of Education, Topeka, 1972.

E. *Iowa High School Curriculum — Manufacturing,* Iowa State University, The State Department of Education, Des Moines, 1986.

F. Riehm, Sarah. *The Teenage Entrepreneur's Guide.* Chicago: Surrey Books, 1987.

G. Wright, R. Thomas and Richard M. Henak. *Exploring Production.* South Holland, IL: Goodheart-Willcox Co., 1985.

H. Wright, R. Thomas and Len Sterry. *Industry and Technology Education: A Guide for Curriculum Designers, Implementors, and Teachers.* Lansing, IL: Technical Foundation of America.

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

INFORMATION SHEET

I. **Terms and definitions**

A. Capital — Money, buildings, machinery, and investments that are used, or available, to make products or services

B. Entrepreneur — Person who owns and runs a new business, often based on new ideas

(NOTE: This is from the French word meaning "enterpriser".)

C. Free enterprise — Marketing-centered political/economic system which encourages as little government intervention and control as possible

D. License — Legal or formal permission from a competent authority to engage in a business, occupation, or activity otherwise unlawful

E. Monopoly — Business which is the only producer of a good or service; one which has no competition

F. Profit — Economic reward for filling the needs and wants of consumers; return received by a business after all operating expenses have been paid

G. Stock — Shares of ownership of a corporation

II. **Characteristics of a free enterprise system** (Transparency 1)

A. Freedom to enterprise

1. Individuals have the right to start, operate, and end their own businesses.

2. Individuals must accept risk when they open a business.

3. Individuals have the right to earn a profit and invest or spend it as they choose.

B. Ownership of property — Individuals have the right to own and sell their personal property.

C. Consumer choice — Individuals are free to choose which goods and services they wish to buy (and whether or not they wish to buy any at all.)

INFORMATION SHEET

D. Competition

1. Limits price that a business can effectively charge for its goods and services.

2. Encourages better quality merchandise and broader services within the businesses' operations.

   Examples: Convenient parking, use of credit, repair services, layaway

3. Encourages production of broader line of goods and services.

E. Supply and demand

1. Supply — Quantity of a product or services that *producers* are willing and able to make available for sale at a specific price and time.

2. Demand — Quantity of a product or service that *consumers* are willing and able to buy at a specific price and time.

3. Interaction of supply and demand determines what will be produced and what prices will be charged.

4. Laws of supply and demand directly affect prices.

   a. As demand goes up and supply stays the same, prices go up.

   b. As demand goes down and supply stays the same, prices go down.

   c. As supply goes up and demand stays the same, prices go down.

   d. As supply goes down and demand stays the same, prices go up.

(NOTE: The free enterprise system is the economic system used by the United States, Canada, most of the countries of Western Europe, and other "free world" countries. The free enterprise system is sometimes called *capitalism*.)

III. **Items needed by manufacturing enterprise** (Transparency 2)

A. Finance — The money needed to start and maintain a manufacturing enterprise

B. Materials — All items used to manufacture a product

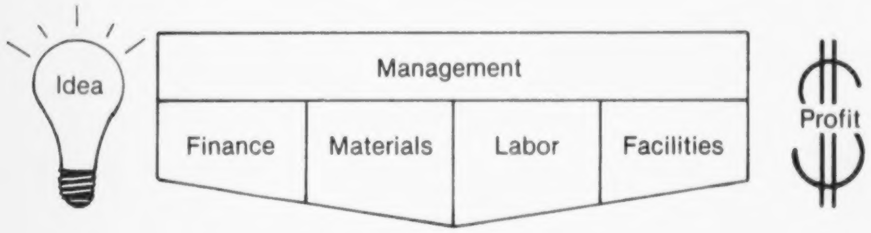
C. Labor — People who perform the manufacturing operations

INFORMATION SHEET

D. Facilities — All the physical things needed to convert the materials to a product; includes all utilities, energy resources, buildings, and equipment

E. Management

1. Plans, organizes, directs, and controls the other four resources.
2. Plans the structure of the enterprise and makes sure the other resources work together to produce a profit for the enterprise.



IV. **Forms of ownership of enterprises**

A. Individual proprietorship — Has one owner

B. Partnership — Has two or more owners

C. Corporation — Has many owners, sometimes thousands

Examples: American Telephone and Telegraph (AT&T), General Electric

D. Cooperative — An enterprise or organization owned and operated for the benefit of those using its services

Examples: Agricultural co-ops, rural electric cooperatives

(NOTE: Most companies are profit-centered. They are formed to make money for the owner.)

INFORMATION SHEET

V. Characteristics of individual proprietorships

A. Features of individual proprietorships

1. One person is the owner.
2. The single owner furnishes all the capital.
3. The owner collects the profits, or suffers the losses.
4. The owner makes the decisions.
5. The business is usually small.

B. Advantages of individual proprietorships

1. Easy to form and to dissolve.
2. Free from corporate taxes.
3. Free of many government controls.
4. All profits go to the owner.
5. One person makes all important decisions.
6. The owner is free to work the business hard or leisurely.
7. Financial records are private. No public disclosure of records must be made by the owner.

C. Disadvantages of individual proprietorships

1. Owner has unlimited liability — Even the owner's personal assets (home, car, etc.) can be repossessed to pay the debts of the business.
2. Can be unstable — The business may not run smoothly if the owner is absent frequently, is in poor health, or dies.
3. Possibility of expanding is limited — The single owner may not have sufficient capital to expand.
4. Expertise may be deficient — Few people understand well all aspects of successful business management.

   (NOTE: Many small businesses are changed to corporations when they become too large or too complex to be run by an individual. The original owner may retain control (if not full ownership) by retaining more than 50% of the stock issued.)

INFORMATION SHEET

VI. Characteristics of the general partnership

A. The general partnership is similar to the individual proprietorship. The chief difference is that the partnership has two or more owners.

B. The extent of ownership by the partners may vary which is usually determined in advance. The extent of ownership may be based on the percentage of total capital invested by each, or in the extent of the management responsibilities undertaken by each partner, or a combination of these.

(NOTE: For example, in the case of professional football teams there may be a managing general partner that owns 1/3 of the corporation and 6 or 7 other partners that own something else.)

C. Advantages of the general partnership

1. Easy to form and to dissolve.
2. Not liable for corporate taxes.
3. Free from many government controls.
4. Additional management expertise, especially if partners bring different talents to the business.
5. A sharing of business problems—one person does not have to do all the worrying.
6. Larger sums of money for capital investment.

D. Disadvantages of the general partnership

1. Can be unstable — Absence, poor health, or death of any partner can hurt the business.
2. Has unlimited liability — Each partner's personal wealth may be repossessed to pay business debts.

   (NOTE: The extent of indebtedness of partners is not limited to the extent of each one's investment. Each partner is responsible for all debts of the business, regardless of the percentage of ownership.)

3. Has limited expansion potential, though not as limited as in the individual proprietorship.
4. Is subject to unresolvable disagreements between the partners.

   (NOTE: Even if arguments between partners are not related to business matters, they can seriously damage the health of the enterprise.)

INFORMATION SHEET

VII. Characteristics of a corporation

(NOTE: Most large manufacturing enterprises, and many small ones, are "incorporated.")

A. The corporation is considered a legal entity — A legal "being" having a life separate and distinct from the owners. Hence,

   1. The liability of the owners is limited to the extent of their investment.

   2. Individuals may invest in a corporation without risking their total personal fortunes.

      (NOTE: If you invest $100 in a corporation and the corporation fails, you lose only your investment. If a corporation goes bankrupt, all assets are sold and the money is distributed to the creditors. Any unpaid debts are written off and taken as a loss by the creditors.)

B. The vast majority of the owners of a corporation (shareholders) usually take little or no part in the management of the company.

C. Advantages of corporations

   1. Limited liability for investors — Investors are not responsible for the debts of the company.

   2. More stability — The corporation is not affected by the absence, ill health, or death of investors, or by the exchange of investments.

   3. Unlimited capital — When money is needed for expansion, new stock issues provide the additional capital quickly.

D. Disadvantages of corporations

   1. Are subject to corporate taxes and extensive government regulations.

   2. Are more difficult to form and to dissolve because of certain government regulations which must be observed.

   3. Investors are widely scattered; hence, they may take little interest in company management.

VIII. Types of corporations (Transparency 3)

A. Parent or holding corporation — A corporation that owns all or most of the stock of another corporation. Most subsidiary corporations produce products or services related to the parent corporation.

INFORMATION SHEET

B. Membership corporations — Do not issue stock. Most are non-profit organizations like the Red Cross, Salvation Army, churches, etc.

C. Municipal corporations — Cities, counties, and school districts that run the business of the community

IX. **Characteristics of entrepreneurs** (Assignment Sheet #1)

A. Are very self-confident

B. Have a high energy level

C. Are self-motivated "doers" rather than "thinkers"

D. Have imagination and can see opportunities for profit where others do not

E. Are aware of people and their needs as well as the market and whether or not these needs are being met or can be improved

F. Are willing to take a risk; choose a challenge over security

G. Are driven by a desire to achieve success and receive recognition

H. Are optimistic

X. **Steps in starting a business**

A. Commit yourself to starting a business.

B. Develop a written plan of action for the business. (What, where, how, when)

C. Obtain legal and financial help in preparing to start a business.

(NOTE: Help with licenses, papers, corporate matters, and recordkeeping is needed.)

D. Gather funds (money) to start business.

E. Obtain and set up the enterprise facilities.

F. Hire employees and make job assignments.

G. Determine the opening date and plan for it carefully.

H. Open the business with great expectations for the best and a healthy fear of the worst.

INFORMATION SHEET

XI. **Steps necessary to form a corporation** (Assignment Sheet #2)

(NOTE: A corporation must be *chartered* by state government. This is more complicated than obtaining a license or permit.)

A. Prepare and file *articles of incorporation*. They should include:

1. Name of company
2. Purpose of company
3. Names and addresses of people forming
4. Location of company office
5. Type and value of stock to be issued

B. Receive charter from state. They are accepted if:

1. Name of proposed company is acceptable.
2. Certificate is properly completed.
3. Proposed activities are within state laws.

C. Prepare a set of bylaws. These should include:

1. Date and place of annual stockholders' meetings
2. Date and location of meetings of board of directors
3. List of corporate officers, their duties, method of appointment, and terms of office
4. The number of directors, their duties, and terms of office
5. Types of proposals that must be approved by stockholders
6. Method to be used to amend bylaws

D. Elect board of directors. This board will plan and direct company actions and policies.

XII. **Products and services and the labor force**

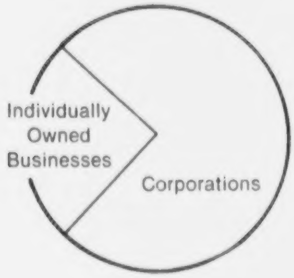
A. Corporations account for over 75% of all the products and services provided by U.S. industries.

B. Corporations also employ over 80% of the U.S. work force.

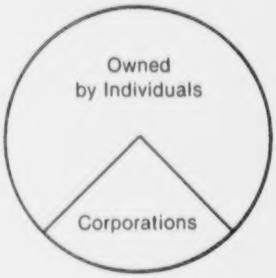
INFORMATION SHEET

C. However, three out of every four businesses are owned by individuals.

D. One can conclude that industry in the United States consists of a vast number of very small businesses and a much smaller number of large corporations.



Goods Produced in the U.S.



Businesses in the United States

XIII. Legal requirements that affect free enterprise organizations

A. The American economic system is based on free enterprise.

  1. This means that government avoids interfering in businesses except when necessary.

  2. Some governmental control, however, is necessary in order to protect the consumer and other businesses from unfair trade practices.

B. Laws regulating business cover two areas.

  1. The license, permit, or charter to operate.

  2. The protection of people and the environment.

C. Laws regulating business originate at the local or state level. These vary a great deal from state to state and from locality to locality.

XIV. License or permit

A. Is required for most individual proprietorships and partnerships

B. Is usually issued by the local or state government for a small fee

C. Its chief purpose is to provide the local government with a record of the existence of the business.

INFORMATION SHEET

D. Alerts government authorities to check the business for compliance with other laws.

E. Contains information about the business.

1. Type and location of the business
2. Name of the owner or owners
3. Permission to operate
4. Issue date
5. Expiration date
6. Signature of authorized government official

XV. **Governmental agencies established to monitor businesses**

(NOTE: Once a business is licensed and chartered, it must observe many laws designed to protect both the people involved and the environment.)

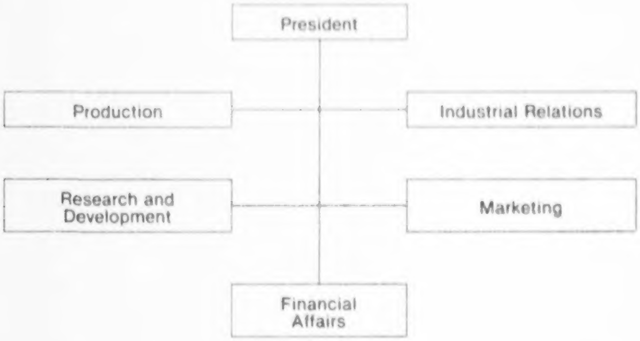
A. Environmental Protection Agency (EPA) — Concerned with conservation and protection of the environment

B. Occupational Safety and Health Act (OSHA) — Establishes and enforces legislation regarding the health and safety of workers in the workplace

C. Interstate Commerce Commission (ICC) — Regulates the transportation and sale of goods between the various states

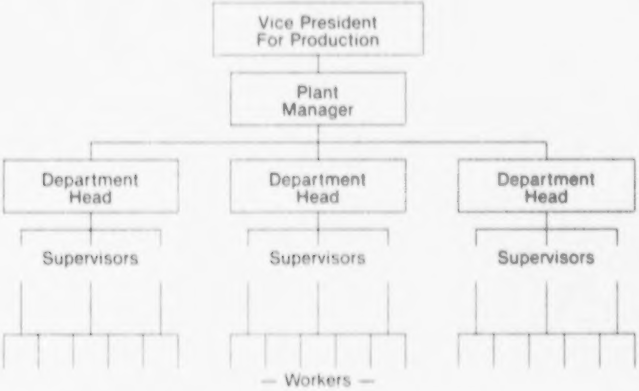
XVI. **Organizational structures used in manufacturing enterprise systems** (Assignment Sheets #3-#5)

A. Line organization — Provides a single line of authority. Best for small companies.

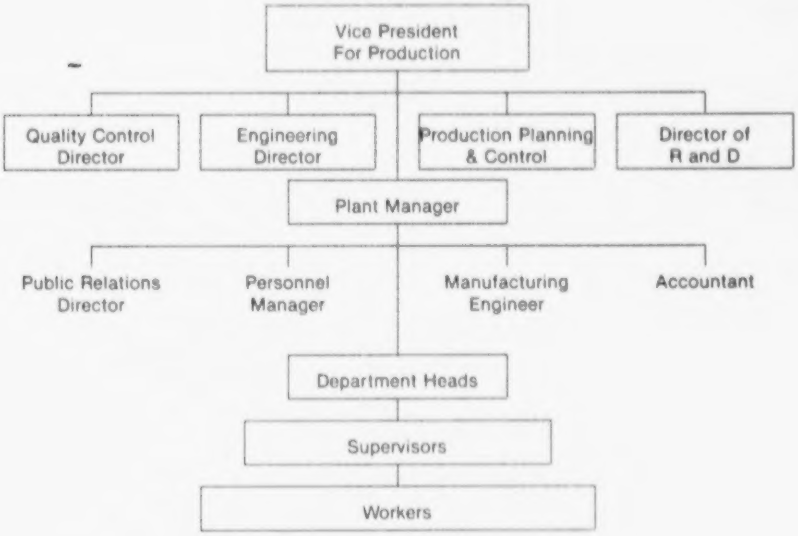


INFORMATION SHEET

B. Line and staff organization — Necessary in larger companies. Managers have advisors.


Vice President For Production
Plant Manager
Department Head
Department Head
Department Head
Supervisors
Supervisors
Supervisors
— Workers —

C. Line and functional staff organization — Best suited for very large companies. Upper middle level managers make many decisions.


Vice President For Production
Quality Control Director
Engineering Director
Production Planning & Control
Director of R and D
Plant Manager
Public Relations Director
Personnel Manager
Manufacturing Engineer
Accountant
Department Heads
Supervisors
Workers

INFORMATION SHEET

XVII. **Major organizational components comprising the manufacturing system** (Transparency 4)

(NOTE: These organizational components, while rather separate in function, must work closely together for success. Each component cannot function all alone, each must depend upon the others. For example, *production* is dependent upon *finance* for money, *research and development* for ideas, *industrial relations* for labor and management to function properly, and *marketing* to sell goods.)

A. Research and development — Developing and refining ideas leading to new or improved products, processes, and materials

(NOTE: Protection of these ideas is essential; therefore, patents, copyrights, and licensing are often placed on finished goods and services.)

1. Research is conducted for the purpose of discovering new knowledge
2. Development involves finding applications for the knowledge that research has uncovered

B. Production — Activities resulting in the manufacture of a product

1. Production planning and control — Scheduling for labor, materials, and machines
2. Manufacturing and plant engineering — Plant layout, tooling, jigs and fixtures, templates, layout handling, time study, and method study
3. Manufacturing — Producing parts, subassemblies, and final assemblies
4. Quality control — Ensuring that the product meets standards

C. Industrial relations — Activities dealing with personnel, labor, and public relations

1. Personnel relations — Develops the labor force of human resources needed by the enterprise; involved in hiring and firing people, employee training, safety seminars, employee services, etc.
2. Labor relations — Attempts to promote and maintain positive relations and attitudes between the company and the workers; if the relationship between the company and the workers breaks down, collective bargaining and grievance procedures may be used.
3. Public relations — Is responsible for maintaining and improving the company's image in the eyes of the public; promotes public acceptance of company products, procedures, and policies

INFORMATION SHEET

D. Marketing — Activities that determine type, quality, and quantity of products to be produced and that cause a company's products to be purchased

   1. Research — Availability of product and public interest in product; establishing price

   2. Advertising — Making the public aware of and creating a demand for a product or service; motivating the customer to buy products or services

   3. Packaging — Containers used to hold and display products

   4. Sales — Consummation of an agreement to exchange items of value; both seller and buyer benefit from the exchange

   5. Distribution — Getting the product from the manufacturer to the consumer

E. Financial affairs — Activities concerned with obtaining and monitoring company funds

   1. Finance — Obtaining sufficient operating funds and investing surplus funds; funds are appropriated from various sources.

      a. Bonds — Certificates of public or private indebtedness. (Money is loaned to a company with the understanding it will be paid back). Money is earned by the bond owner in the form of interest.

      b. Stock — Shares of ownership of a corporation. Money is earned by the stockholder in the form of dividends. Each share of stock represents an interest in the company. For example, if there are 1000 shares of stock, each share represents $^{1}/_{1000}$th interest in the company.

      c. Dividends and interest — The forms of money earned by owners of stocks and bonds.

      d. Personal savings — Money saved by an individual.

      e. Loans — Money received from banks, finance companies, or friends.

   2. Control — Proposing and following budgets, maintaining records, and preparing financial reports

   3. Purchasing — Buying the quantity and quality of materials, services, and equipment needed

INFORMATION SHEET

XVIII. **Types of stocks**

- A. Common stock — Simplest form of stock; when profits are high, dividends are high, and vice-versa
- B. Preferred stock — Preferred by stockholder; benefits include a claim to assets before common stockholders

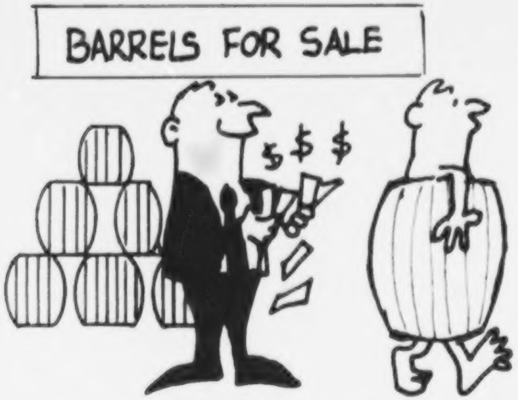
XIX. **Parts of stock certificate** (Transparency 5)

- A. Name of company
- B. Name of stockholder
- C. Number of shares
- D. Value of stock
- E. Certificate number
- F. Date
- G. Signatures of company officers (at least president and secretary)

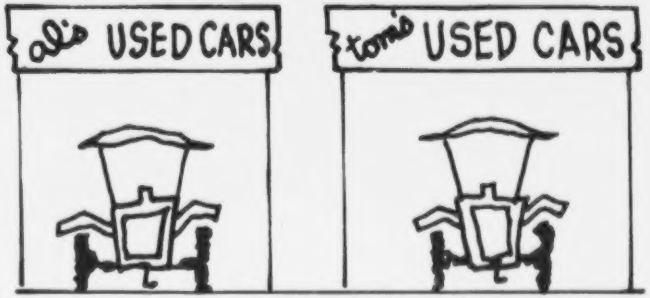
XX. **Buying, selling, and recording stock sales** (Assignment Sheets #6 and #7)

- A. Buying and selling stock
    1. Most stocks are sold by individuals and companies through stockbrokers.
    2. Sales of stock are regulated by federal and/or state government agencies.
    3. The Articles of Incorporation list the number and value of shares available.
- B. When recording the sale of stock, records should include:
    1. Name of stockholder
    2. Purchase date
    3. Number of shares purchased
    4. Total value of purchase

Characteristics of a Free Enterprise System


BARRELS FOR SALE
$ $ $

Supply & Demand


al's USED CARS
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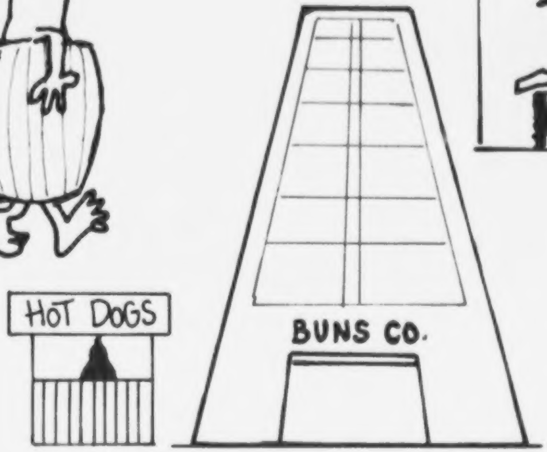
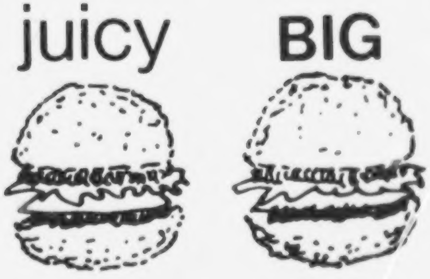
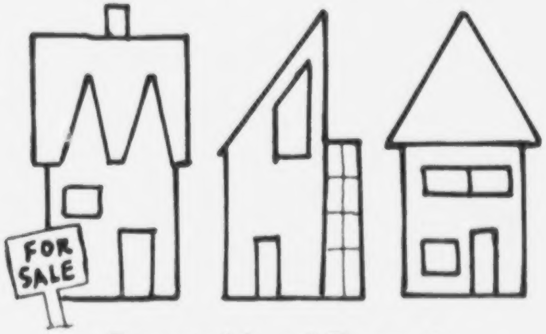
Competition


HOT DOGS
BUNS CO.

Freedom to Enterprise

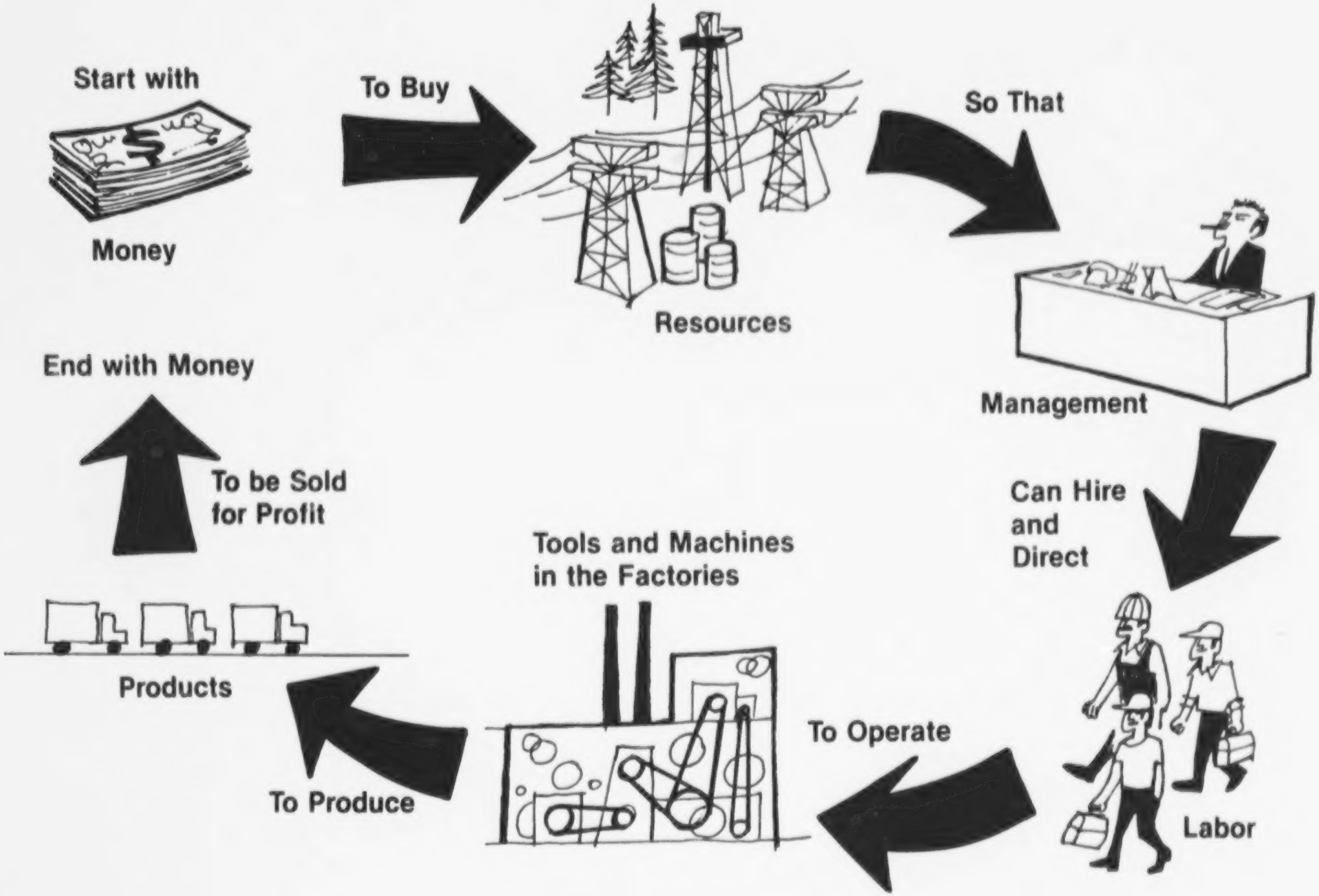


Consumer Choice



Ownership of Property

The Major Elements of Manufacturing



Start with

Money

To Buy

Resources

So That

Management

Can Hire
and
Direct

Labor

To Operate

Tools and Machines
in the Factories

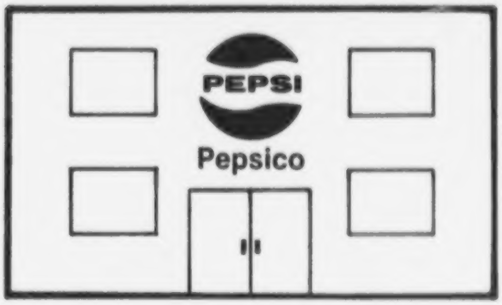
To Produce

Products

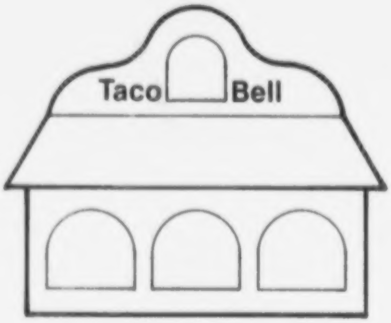
To be Sold
for Profit

End with Money

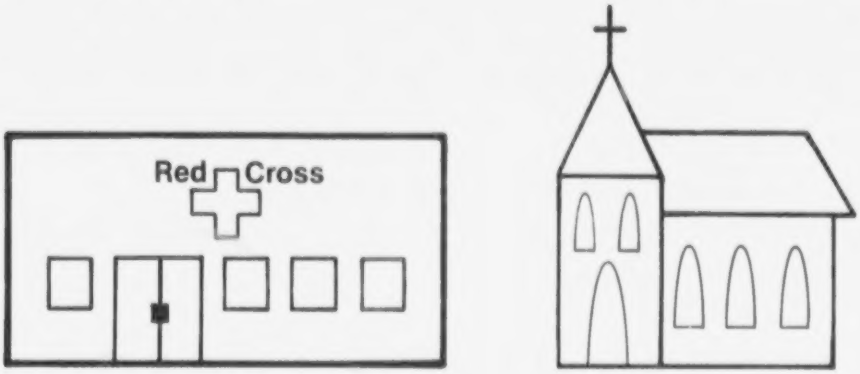
Types of Corporations


PEPSI
Pepsico

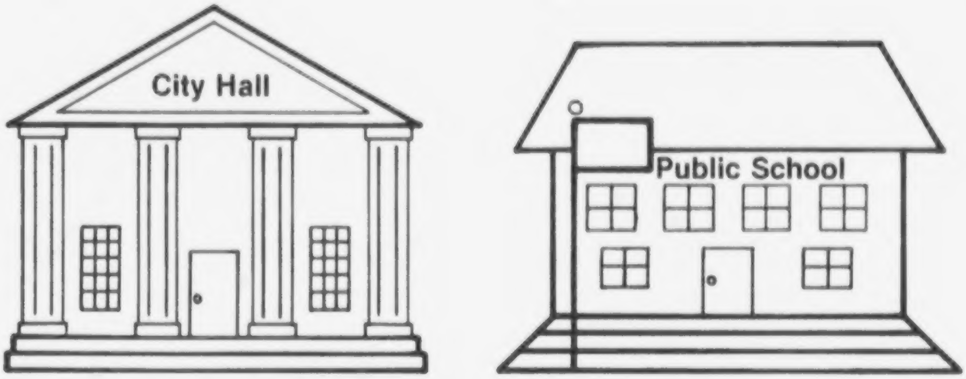
Parent Corporation



Subsidiary



Membership Corporations


City Hall
Public School

Municipal Corporations

Areas of a Manufacturing Organization

Research and Development

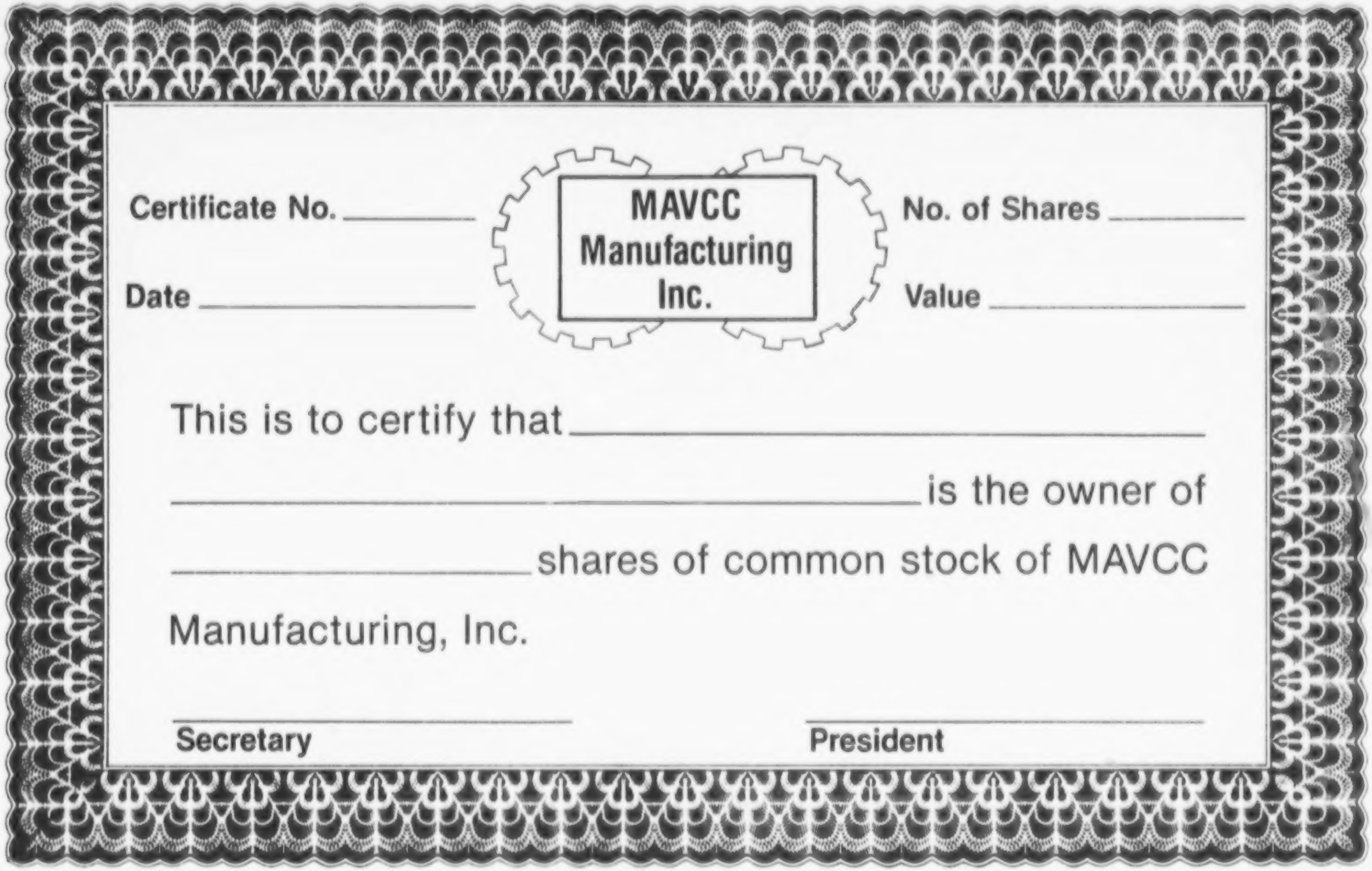
Production

Industrial Relations

Marketing

Financial Affairs

Parts of a Stock Certificate



Certificate No. ________

Date ________

MAVCC
Manufacturing
Inc.

No. of Shares ________

Value ________

This is to certify that ______________________________
______________________________ is the owner of
________________ shares of common stock of MAVCC
Manufacturing, Inc.

________________ Secretary

________________ President

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #1 — COMPLETE AN ENTREPRENEURSHIP CHECKLIST

NAME ______________________________ SCORE ____________

Directions: Read through the following entrepreneurship checklist and answer each question as honestly as possible. There are no right or wrong answers. This assignment is designed to assist you in determining if you have high potential in entrepreneurship.

(NOTE: Remember, not everyone has the characteristics to make a good entrepreneur. Many successful people are *not* entrepreneurs, while many are.)

ENTREPRENEURSHIP CHECKLIST

	YES	NO
1. Are you very confident in yourself and your abilities?	☐	☐
2. Do you have a lot of energy? (Always on the go, require little sleep)	☐	☐
3. Are you a self-motivated doer? (No one has to prod or nag you to do things, you want to get the job done)	☐	☐
4. Do you have good ideas for businesses that could make money?	☐	☐
5. Are you willing to take risks in order to achieve success?	☐	☐
6. Have you set long-term goals for the future?	☐	☐
7. Is being on time for activities important to you?	☐	☐
8. Are you competitive? (Like to compete in athletics, contests, etc.)	☐	☐
9. Are you organized? (Keep personal records, notebooks, social calendar in good order)	☐	☐
10. Are you a leader? (Friends look to you for advice or to make decisions for the group; elected to office)	☐	☐
11. Do you work well by yourself?	☐	☐
12. Do you have a lot of friends or acquaintances in your community?	☐	☐
13. Do you have a great desire to be recognized by others?	☐	☐
14. Are you confident in talking to adults about money, assistance, or support for projects that interest you? (e.g. raising funds for a student organization)	☐	☐
15. Have you ever had a job and received wages?	☐	☐
16. Are you optimistic and aware of what's going on around you?	☐	☐

ASSIGNMENT SHEET #1

RESULTS OF CHECKLIST

Count up the total number of "Yes" responses and write the total here. ____________

Yes Responses

0-4	May want to consider other alternatives to entrepreneurship
5-8	Fair potential for being an entrepreneur
9-12	Good potential for being an entrepreneur
13-16	Very good potential for being an entrepreneur and managing own business

At the conclusion of this activity, you may want to visit with your teacher or counselor to discuss the results of the checklist.

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #2 — PREPARE AND FILE ARTICLES OF INCORPORATION

NAME ______________________________ SCORE ______________

Directions: Prepare articles of incorporation appropriate for your classroom mass production activity. Before completing the worksheet provided, the class as a whole must decide on the following:

1. Agree on a name for the corporation.
2. Identify the purpose of the corporation.
3. Select a company trademark.
4. Collect the names and addresses of the incorporators.
5. Identify the location of the company within the state.
6. Determine the value and number of shares of stock to be issued.
7. Elect a board of directors who in turn select management positions.

ASSIGNMENT SHEET #2

ARTICLES OF INCORPORATION

of

(name of corporation)

ARTICLE I: The name of the corporation is ______________________________.

ARTICLE II: The address of the Corporation's registered office in the State of ____________________ is

____.

The name of the Corporation's Registered Agent at such address is ______________________________.

ARTICLE III: The purpose of the Corporation is to ______________________________

____.

ARTICLE IV: The total number of shares which the Corporation shall have authority to issue is ____________ shares, each of the shares having a par value of $ ____________, thereby resulting in the Corporation have total authorized capital stock in the amount of ____________, all of which is Common Stock.

The Board of Directors of the Corporation shall have full authority, to the extent permitted by law, to increase, decrease, or otherwise adjust the capital stock of the Corporation.

ARTICLE V: The name and mailing address of each incorporator is as follows:

Name	Address

ARTICLE VI: The Board of Directors is expressly authorized:

A. To adopt, amend, or repeal the By-Laws of the Corporation.

B. To authorize mortgages, security interests, and liens upon the real and personal property of the Corporation.

ARTICLE VII: Meetings of shareholders, location of the books of the Corporation, and elections and meeting of the Board of Directors shall be as the By-Laws of the Corporation may provide.

THE UNDERSIGNED being the incorporator(s) hereinbefore named hereby declare and certify that this is the act and deed of the undersigned and that the facts herein stated are true, as of this (date) ____________________.

______________________________ ______________________________

______________________________ ______________________________

STATE OF ____________)
) SS
COUNTY OF ____________)

Subscribed and swore to before me on this ____________ day of ____________, 19______.

____
NOTARY PUBLIC

(SEAL)

____
Date my commission expires

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #3 — DRAW THE ORGANIZATIONAL STRUCTURE OF A MEDIUM-SIZED MANUFACTURING COMPANY

NAME ________________________________ SCORE ____________

Directions: Contact a relative or neighbor that works for a manufacturing company with at least 50 employees. (You may phone a company directly if you desire.) Complete the following.

1. Name of company ________________________________

2. Products manufactured ________________________________

   ____

3. Number of employees ________________________________

4. Sketch of organizational structure (label blocks)

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #4 — DRAW AN ORGANIZATIONAL STRUCTURE FOR A CLASSROOM MANUFACTURING ACTIVITY

NAME ____________________________ SCORE ______________

You are required to organize your class into a company that will produce and sell a product. In order for your company to function efficiently, an appropriate organizational structure must be identified.

Directions: Select one or more of the three structures described in the information sheet or a combination of two or more. In the space provided, sketch a chart that would permit your class to produce twenty or more of a small product.

Criteria for grading includes:

1. Is it appropriate for the class size?
2. Is it neat and legible?
3. Are all blocks labeled?

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #5 — DRAW A DEPARTMENTAL ORGANIZATIONAL CHART AND WRITE A JOB DESCRIPTION FOR ONE OF THE MANAGEMENT POSITIONS

NAME ______________________________ SCORE ____________

Directions:

1. Draw a Departmental Organization Chart appropriate for your class.
2. List the names of probable managers and job titles in the blocks.
3. Your teacher will assign you a mangement position which needs a job description.
4. On a separate sheet of paper, write a description for the assigned management positions. (Example Pres., V-P...)

   (NOTE: Job descriptions for labor will be developed in Unit VI.)

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #6 — SIMULATE THE BUYING AND SELLING OF STOCK AND RECORD ALL TRANSACTIONS

NAME ______________________________ SCORE ____________

Directions: For this assignment, you are to simulate the buying and selling of stock. Assume that you have $1000 to invest in the stock market. Do the following:

1. Invest all or part of the $1000 on any stock or combination of stocks (maximum of 5 different stocks) listed on the New York Stock Exchange.

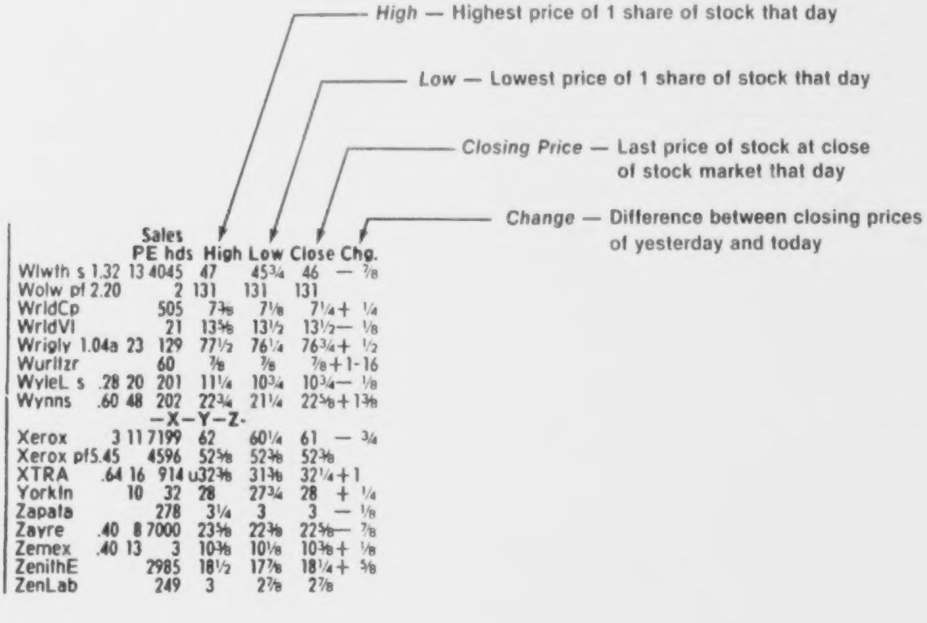
   (NOTE: Profits made on stocks can be reinvested.)

2. Record all stock transactions (purchases and sales) on the worksheet provided. Buy and sell stocks as you wish.

   (NOTE: The buying or selling price used for this assignment equals the closing price of the share of stock.)

3. Monitor the performance of your particular stocks on a day-to-day basis for two weeks (10 working days).

   (NOTE: Stock performance can be found in the financial section of most daily newspapers.)



High — Highest price of 1 share of stock that day

Low — Lowest price of 1 share of stock that day

Closing Price — Last price of stock at close of stock market that day

Change — Difference between closing prices of yesterday and today

		PE	Sales hds	High	Low	Close	Chg.
Wlwth s	1.32	13	4045	47	45¾	46	— ⅞
Wolw pf	2.20		2	131	131	131	
WrldCp			505	7⅜	7⅛	7¼	+ ¼
WrldVl			21	13⅝	13½	13½	— ⅛
Wrigly	1.04a	23	129	77½	76¼	76¾	+ ½
Wurlitzr			60	⅞	⅞	⅞	+1-16
WyleL s	.28	20	201	11¼	10¾	10¾	— ⅛
Wynns	.60	48	202	22¾	21¼	22⅝	+ 1⅜
			—X—Y—Z-				
Xerox	3	11	7199	62	60¼	61	— ¾
Xerox pf	5.45		4596	52⅝	52⅜	52⅜	
XTRA	.64	16	914	u32⅜	31⅜	32¼	+ 1
Yorkln		10	32	28	27¾	28	+ ¼
Zapata			278	3¼	3	3	— ⅛
Zayre	.40	8	7000	23⅝	22⅜	22⅝	— ⅞
Zemex	.40	13	3	10⅜	10⅛	10⅜	+ ⅛
ZenithE			2985	18½	17⅞	18¼	+ ⅝
ZenLab			249	3	2⅞	2⅞	

ASSIGNMENT SHEET #6

4. At the conclusion of two weeks (10 working days), sell all stock holdings at their closing prices, and record profit and loss totals.

   (NOTE: You should spend some time researching a company and their performance record before buying their stock. Sources of information about stock include teachers, librarians, friends, newspapers, magazines, and stockbrokers.)

INVESTMENT WORKSHEET

	BUYING INFORMATION			SELLING INFORMATION			RESULTS	
Name of Stock	Date	No. of Shares	Price (Closing Price)	Date	No. of Shares	Price (Closing Price)	Profit	Loss
					Total			
							Profit	Loss

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ASSIGNMENT SHEET #7 — SELECT A STOCK AND MONITOR ITS PERFORMANCE THROUGHOUT THE SEMESTER

NAME ______________________________ SCORE ____________

Directions: Select a single share of stock from your local newspaper. Use the weekly closing price (Friday) of your stock to complete the chart below and the graph on the back of this page.

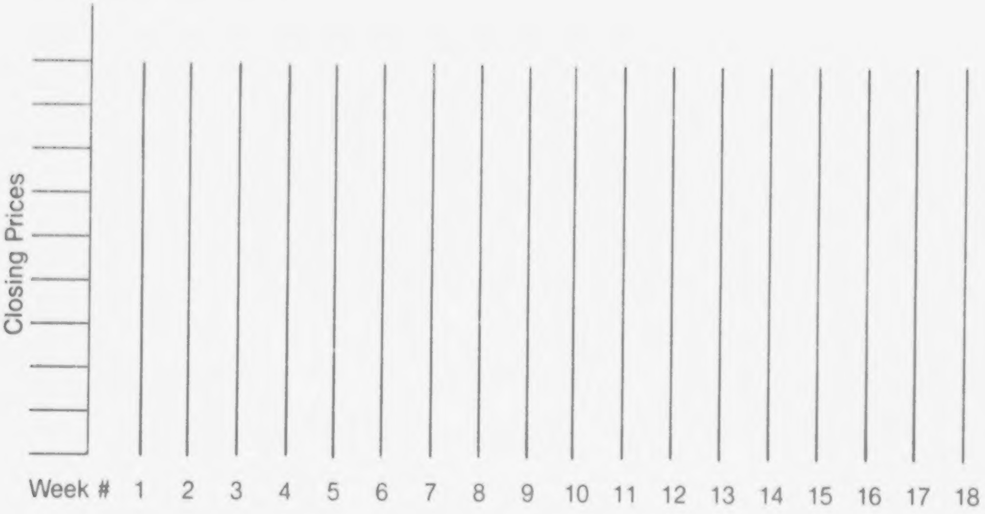
Name of Stock ______________________________

Date __________ to __________

Week #	Dividend per share	Sales (hds.)	High	Low	Close	Change
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

ASSIGNMENT SHEET #7

Graph the closing price



MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

TEST

NAME ______________________ SCORE ____________________

1. Match the terms on the right with their correct definitions.

_____a. A person who owns and runs a business, often based on new ideas

_____b. Business which is the only producer of a good or service; one which has no competition

_____c. Economic reward for filling the needs and wants of consumers

_____d. Shares of ownership of a corporation

_____e. Money, buildings, machinery, and investments that are used, or available, to make products or services

1. Capital
2. Entrepreneur
3. Free enterprise
4. License
5. Monopoly
6. Permit
7. Profit
8. Stock

2. Select from the following list the correct characteristics of a free enterprise system by placing an "X" in the appropriate blanks.

_____a. Supply and demand

_____b. Competition

_____c. Right to monopolize

_____d. Consumer choice

_____e. Ownership of property

_____f. Freedom to enterprise

TEST

3. Match the items needed by the manufacturing enterprise listed on the right with the correct descriptions.

   _____a. All the physical things needed to convert the materials to a product, includes all utilities, energy resources, buildings, and equipment

   _____b. People who perform the manufacturing operations

   _____c. The money needed to start and maintain a manufacturing enterprise

   1. Materials
   2. Facilities
   3. Finance
   4. Labor
   5. Management

4. Distinguish between the forms of ownership of enterprises by placing an "X" next to the description of an individual proprietorship.

   _____a. Owned and operated for the benefit of those using its services; example is a rural electric co-op

   _____b. Has two or more owners; example is Simon and Son Auto Repair

   _____c. Has one owner; example is Suzi's Boutique

   _____d. Has many owners; examples are AT&T, IBM, and Xerox

5. Complete the following statements concerning individual proprietorships by circling the best answers.

   a. In an individual proprietorship the business is usually (**small, large**).

   b. An individual proprietorship is (**easy, difficult**) to form and to dissolve.

   c. In an individual proprietorship all profits go to the (**stockholders, owner**).

   d. A disadvantage of the individual proprietorship is that the owner has unlimited (**assets, liability**).

6. Complete the following statements concerning general partnerships by circling the best answers.

   a. The general partnership (**is, is not**) liable for corporate taxes.

   b. Each partner (**is, is not**) responsible for business debts.

   c. The business has (**limited, unlimited**) expansion potential.

TEST

7. Select true statements concerning corporations by placing an "X" next to the true statements.

______a. When individuals invest in a corporation, all of their personal fortunes are liable for the corporation's debts.

______b. The majority of corporation shareholders take little part in the management of the company.

______c. Corporations usually have unlimited capital.

______d. Corporations are subject to corporate taxes.

______e. Corporations are easy to form and to dissolve.

8. Match types of corporations on the right with the correct descriptions.

______a. Owns all or most of the stock of another corporation

______b. Does not issue stock; includes the Red Cross and churches

______c. Cities, counties, and school districts that run the business of the community

1. Municipal corporation
2. Parent or holding corporation
3. Cooperative corporation
4. Membership corporation

9. Select from the following list the characteristics of an entrepreneur by placing an "X" in the appropriate blanks.

______a. Self-confident

______b. Are "thinkers" rather than "doers"

______c. High energy level

______d. See opportunities for profit that others do not

______e. Pessimistic and unaware

______f. Do not desire recognition for achievements

______g. Prefer security instead of new challenges

TEST

10. Arrange in order the steps for starting a business by placing a "1" in front of step 1, a "2" in front of step 2, etc.

_____a. Hire employees and make job assignments.

_____b. Obtain legal and financial help.

_____c. Open the business.

_____d. Develop a written plan of action.

_____e. Commit to starting a business.

_____f. Gather funds to start business.

_____g. Determine the opening date.

_____h. Obtain and set-up facilities.

11. Arrange in order the steps necessary to form a corporation by placing a "1" in front of step 1, a "2" in front of step 2, etc.

_____a. Receive charter from state.

_____b. Elect board of directors.

_____c. Prepare the articles of incorporation.

_____d. Prepare a set of by-laws.

12. Select true statements concerning products and services and the labor force by placing a "T" in front of true statements and an "F" in front of false statements.

_____a. Corporations account for 75% of all the products and services provided by U.S. industries.

_____b. There are more large corporations in the U.S. than small businesses.

_____c. Three out of every four businesses are owned by corporations.

_____d. Corporations employ over 80% of the U.S. work force.

TEST

13. Select true statements concerning the legal requirements that affect free enterprise organizations. Place a "T" in front of true statements and an "F" in front of false statements.

_____a. The American economic system is based on free enterprise.

_____b. The government regularly attempts to interfere in business as standard procedure.

_____c. The government does not try to regulate unfair trade practices.

_____d. Laws regulating businesses cover licensing and the protection of people and the environment.

_____e. Laws regulating businesses originate (start) at the national (federal) level.

_____f. Laws regulating businesses vary a great deal from state to state, and from locality to locality.

14. Select from the following list the correct characteristics of a license or permit by placing an "X" in the appropriate blanks.

_____a. Is usually issued by the federal government.

_____b. Is usually issued by the local or state government.

_____c. Provides the government with a record of the existence of the business.

_____d. Contains information about the business such as owner name, issue date, location of business, and signature of authorized government official.

15. Select from the following list three (3) principal government agencies responsible for monitoring businesses. Place an "X" by the correct responses.

_____a. Chamber of Commerce (COC)

_____b. Environmental Protection Agency (EPA)

_____c. Interstate Commerce Commission (ICC)

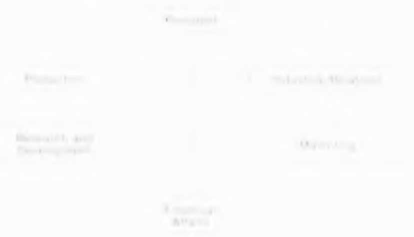
_____d. American Civil Liberties Union (ACLU)

_____e. Occupational Safety and Health Act (OSHA)

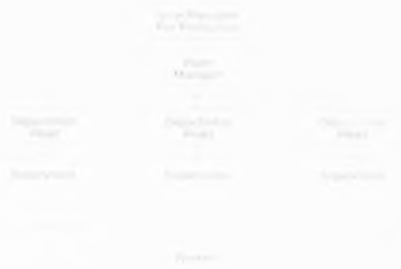
TEST

16. Match the following types of organizational structures used in manufacturing enterprise systems with their diagrams.

_____a.


President
Production
Industrial Relations
Research and Development
Marketing
Financial Affairs

_____b.


Vice President For Production
Plant Manager
Department Head
Department Head
Department Head
Supervisor
Supervisor
Supervisor
Workers

1. Line and functional staff organization
2. Line and staff organization
3. Line organization

17. Match the components of the manufacturing system with the correct descriptions.

_____a.	Activities dealing with personnel, labor, and public relations	1. Research and development
_____b.	Activities resulting in the manufacture of a product	2. Production
_____c.	Activities concerned with obtaining and monitoring company funds	3. Industrial relations
_____d.	Developing and refining ideas leading to new or improved products, processes, and materials	4. Marketing
		5. Financial affairs

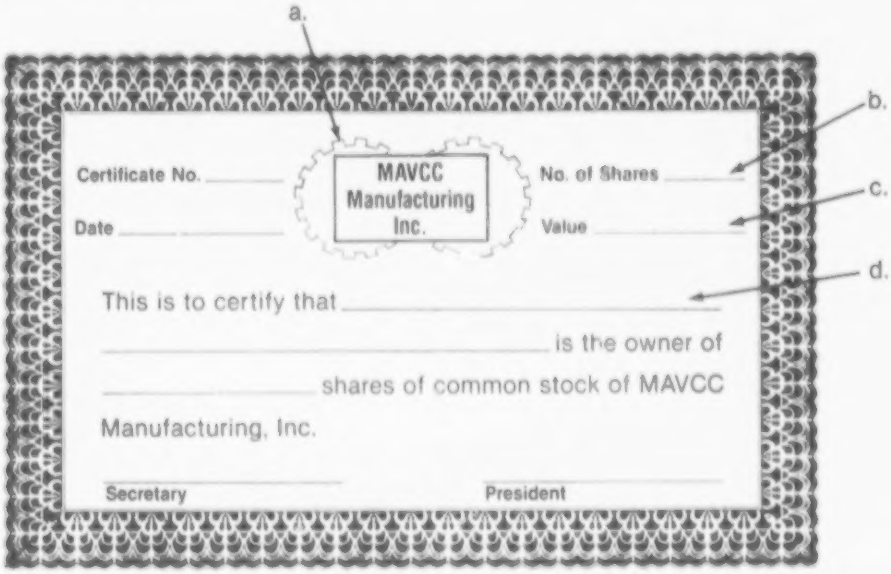
18. Complete statements concerning types of stocks by circling the correct answers.

a. "The form of stock where when profits are high, dividends are high and vice-versa," describes (**common, preferred**) stock.

b. The type of stock that has first claim to assets is called (**common, preferred**) stock.

TEST

19. Label the parts of the following stock certificate by putting the name of the component in the corresponding blank.



Certificate No. ______

Date ______

MAVCC
Manufacturing
Inc.

No. of Shares ______

Value ______

This is to certify that ____________________ is the owner of ______ shares of common stock of MAVCC Manufacturing, Inc.

Secretary ______

President ______

a. ______________________ b. ______________________

c. ______________________ d. ______________________

20. Complete the following statements regarding the buying, selling, and recording of stock sales by circling the answer which best completes the statement.

a. Most stocks are sold through professionals called (**stockbrokers, share peddlers**).

b. Sales of stock are regulated by (**business, government**) agencies.

c. In recording sales of stock, the (**purchase, incorporation**) date of the stock should be recorded.

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

21. Complete an entrepreneurship checklist. (Assignment Sheet #1)

22. Prepare and file articles of incorporation. (Assignment Sheet #2)

23. Draw the organizational structure of a medium-sized manufacturing company. (Assignment Sheet #3)

24. Draw the organizational structure for a classroom manufacturing activity. (Assignment Sheet #4)

25. Draw a departmental organizational chart and write a job description for one of the management positions. (Assignment Sheet #5)

26. Simulate the buying and selling of stock and record all transactions. (Assignment Sheet #6)

27. Select a stock and monitor its performance throughout the semester. (Assignment Sheet #7)

MANUFACTURING ENTERPRISES AND SYSTEMS
UNIT II

ANSWERS TO TEST

1. a. 2
   b. 5
   c. 7
   d. 8
   e. 1

2. a, b, d, e, f

3. a. 2
   b. 4
   c. 3

4. c

5. a. Small
   b. Easy
   c. Owner
   d. Liability

6. a. Is not
   b. Is
   c. Limited

7. b, c, d

8. a. 2
   b. 4
   c. 1

9. a, c, d

10. a. 6
    b. 3
    c. 8
    d. 2
    e. 1
    f. 4
    g. 7
    h. 5

11. a. 2
    b. 4
    c. 1
    d. 3

ANSWERS TO TEST

12. a. T
    b. F
    c. F
    d. T

13. a. T
    b. F
    c. F
    d. T
    e. F
    f. T

14. b, c, d

15. b, c, e

16. a. 3
    b. 2

17. a. 3
    b. 2
    c. 5
    d. 1

18. a. Common
    b. Preferred

19. a. Name of company
    b. Number of shares
    c. Value of stock
    d. Name of stockholder

20. a. Stockbrokers
    b. Government
    c. Purchase

21.-27. Evaluated to the satisfaction of the instructor

MANUFACTURING MATERIALS AND SELECTION
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between manufacturing materials, properties, and methods for identifying and testing them. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to manufacturing materials and selection with the correct definitions.
2. Distinguish between the three states of matter.
3. Match major types of materials used in manufacturing with the correct definitions.
4. Match properties of materials with the correct descriptions.
5. Distinguish between destructive and nondestructive testing of industrial materials.
6. Select from a list the major factors for material selection.
7. Distinguish between the types of wood and their characteristics.
8. Select from a list ways to identify various woods.
9. Select true statements concerning properties and characteristics of wood.
10. Select from a list the advantages of woods.

OBJECTIVE SHEET

11. Complete statements concerning the forms of wood materials and how they are sold.

12. Distinguish between the types of metals.

13. Select true statements concerning metals identification and designation.

14. Select from a list the properties of metal.

15. Complete statements concerning the forms of metal materials and how they are sold.

16. Distinguish between the types of plastics.

17. Select true statements concerning nondestructive and destructive tests for plastics identification.

18. Select from a list the properties of plastics.

19. Match forms of plastics materials with their descriptions.

20. Match types of earth materials with the correct definitions.

21. Complete statements concerning the major parts of a composite.

22. Select true statements concerning the history of composites.

23. Distinguish between the types of composite structures.

24. Select from a list the advantages of composites.

25. Complete statements concerning other manufacturing materials in common use.

26. Complete crossword puzzle of manufacturing materials terminology. (Assignment Sheet #1)

27. Test materials and products. (Assignment Sheet #2)

28. Select and identify materials used for manufacturing products. (Assignment Sheet #3)

MANUFACTURING MATERIALS AND SELECTION
UNIT III

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Discuss the handouts.

H. Integrate the following activities throughout the teaching of this unit:

1. Have the students identify the materials and processes which will be used during the manufacturing enterprise.

2. Provide instruction for each process including safety considerations.

3. Have the enterprise management assign production jobs and prepare jigs and fixtures.

4. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

I. Give test.

J. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

A. Bame, E. Allen and Paul Cummings. *Exploring Technology.* Worcester, MA: Davis Publications, Inc., 1980.

B. Feirer, John F. *Woodworking for Industry.* Peoria, IL: Bennett, 1979.

REFERENCES USED IN DEVELOPING THIS UNIT

C. Heiner, Carl W. and Wayne R. Hendrix. *People Create Technology.* Worcester, MA: Davis Publications, Inc., 1980.

D. *Industrial Education: Materials & Processes.* C.B.I.E. Project, Kansas State Department of Education, Topeka, 1972.

E. *Iowa High School Curriculum — Manufacturing,* Iowa State University, The State Department of Education, Des Moines, 1986.

F. *Secondary Exploration of Technology.* Kansas State College of Pittsburg, The State Department of Education, Topeka, 1974.

G. Tracy, George R. *Modern Physical Science.* New York: Holt, Rinehart, and Winston, 1979.

H. Walker, John R. *Modern Metalworking.* South Holland, IL: Goodheart-Willcox Co., 1976.

I. Wright, R. Thomas and Len Sterry. *Industry and Technology Education: A Guide for Curriculum Designers, Implementors, and Teachers.* Lansing, IL: Technical Foundation of America.

SUGGESTED SUPPLEMENTAL RESOURCES

Films/Videotapes

A. *Plastics: The World of Imagination*, Society of Plastics Engineers

B. *Steel — The Metal Giant*, American Iron and Steel Institute

C. *Aluminum: An Element of Change*, The Aluminum Association, Inc.

D. *Recycling: A Way of Life*, The Aluminum Association, Inc.

Available from:

Modern Talking Picture Service
5000 Park Street North
St. Petersburg, FL 33709
(813) 541-5763

MANUFACTURING MATERIALS AND SELECTION
UNIT III

INFORMATION SHEET

I. **Terms and definitions** (Assignment Sheet #1)

A. Alloy — Two or more elements, one of which is a metal, mixed to form a material which possesses its own unique characteristics

Example: 50/50 solder (melting point [M.P.] 400°F) composed of 50% lead (M.P. 621°F) plus 50% tin (M.P. = 449°F)

B. Element — A substance that cannot be separated into other kinds of substances

C. Ferrous — Metals in which iron is the major ingredient

Examples: Gray iron, steel

D. Inorganic materials — Materials that are not derived from animal or plants

Examples: Ceramics, clay, glass, enamel, concrete, stone

E. Material — Substance which stock is made or composed of and which will be processed into a finished form (goods).

F. Nonferrous — Metal containing little or no iron

Examples: Brass, aluminum, copper

G. Organic materials — Materials derived from living organisms

Examples: Wood, leather, paper, textiles, plastics, rubber, petroleum, natural gas

H. Thermoplastics — Plastics that are heat softened, shaped, and cold hardened, and can be reheated and reshaped again and again; these plastics are recyclable

I. Thermosets — Plastics that set in permanent shape by heat and/or pressure and will not resoften; these plastics are **not** readily recyclable

II. **States of matter**

A. Liquids — Fluid materials that take the shape of their containers and are not very compressible

B. Solids — Materials that retain their shape, are not very compressible, and have definite melting points

C. Gases — Materials that take the shape of their containers, are compressible, could be fluid, and will flow and diffuse easily

INFORMATION SHEET

III. **Major types of materials used in manufacturing** (Transparency 1)

A. Woods — A natural composite material composed primarily of cellulose wood fibers, lignin (natural adhesive), and other substances which make up the trunk and branches of a tree. It is a thermal and electrical insulator, lightweight, and medium in hardness.

B. Metals — A durable, useful manufacturing material which possesses the following properties: is opaque, is a conductor of heat and electricity, can be melted and cast, can be formed by pressure (ductile), has reflective surface when polished, is heavier than water (specific gravity $>$ 1.0), and expands when heated and contracts when cooled.

Examples: Iron, aluminum

C. Plastics — Man-made or synthetic materials that have large heavy molecules; capable of being formed by heat and/or pressure; primarily made from petroleum products.

D. Earth materials — Materials used in manufacturing which are primarily extracted from the earth's crust. These materials are non-metallic, inorganic substances such as clay, sand, and limestone.

E. Composite materials — Materials in which two or more materials are combined providing properties superior to those of the individual materials.

Example: Fiberglass (glass fibers + resin)

(NOTE: Materials used in manufacturing can also be grouped as **metallic** [metals], **polymeric** [plastics and wood], and **ceramic** [earth].)

IV. **Properties of materials** (Transparencies 2-6)

(NOTE: Materials useful for a specific manufacturing purpose need to have certain properties that fit that purpose.)

A. Mechanical properties — Indicate how a material reacts to forces and loads being applied to it. These are most closely associated with serviceability (performance in actual use or service) factors such as strength, toughness, durability, rigidity, and formability. (Transparencies 2-3)

1. Tensile strength — Ability to withstand a pulling force
2. Compression strength — Ability to withstand crushing force as it undergoes pushing and squeezing forces
3. Shear strength — Ability to resist sliding of one surface over another
4. Torsion strength — Ability to withstand twisting force

INFORMATION SHEET

5. Impact strength — Ability to withstand a sudden shock (force) such as a hammer blow or dropped weight; measures toughness or brittleness of a material.

    a. Toughness — Ability of material to absorb shock without breaking

        Example: Nails or leather

    b. Brittleness — Opposite of toughness and ductility. Material does not withstand sudden shock without breaking.

        Example: Window glass

6. Hardness — Resistance to penetration, indentation, and abrasion

7. Ductility — Ability to be bent, twisted, stretched, or changed in shape. Materials that are ductile are formed by pressure into products without breaking. Brittle materials are not. Three properties which relate closely to ductility are:

    a. Plasticity — Materials are bent, twisted, or stretched and remain that way.

        Example: Twisting wire or forming modeling clay

    b. Elasticity — Materials are bent, squeezed, or stretched but come back to or within 5% of their original shape.

        Example: Stretching a piece of elastic, rubber band, or spring and letting it return back to the original shape.

    c. Malleability — Ability to be hammered, rolled, or compressed into a different shape and remain as strong as its original shape

8. Fatigue strength — Ability of a material to absorb repeated stress such as constant flexing or bending

    (NOTE: There are many other mechanical properties that are specific to materials and/or special conditions.)

B. Characteristic properties — Are properties of materials which indicate how nonmechanical influences affect the material. (Transparencies 4-6)

1. Physical and dimensional — These include properties such as moisture content, shape, structure, density, or specific gravity.

    (NOTE: Density is the mass, as measured by weight, per a unit volume of a material. For example, steel is 300 pounds per cubic foot, whereas aluminum is approximately one-third this or 100 pounds per cubic foot.)

INFORMATION SHEET

2. Electrical and magnetic

    a. Conductivity — The ability to conduct electricity as in a *conductor*

        Examples: Silver, copper, aluminum

    b. Resistivity — The ability to resist the flow of electricity as in an *insulator*

        Examples: Glass, rubber, plastic

    c. Magnetic — The ability to be attracted to a magnet

        Examples: Iron, steel

    d. Nonmagnetic — The *in*ability to be attracted to a magnet

        Examples: Rubber, glass, wood, leather

3. Thermal

    a. Thermal conductivity — Ability to conduct (carry) heat

    b. Thermal expansion/contraction — Amount that material expands (enlarges) when subjected to heat or contracts (shortens) when cooled

    c. Melting and freezing points — Temperature at which material becomes a liquid or solid

4. Acoustical — These properties include the ability to transmit, reflect, or absorb sound.

5. Optical — These include color, light reflection (reflectivity), and light transmission (optical clarity). Materials are also classified according to light penetration, including:

    a. Opaque — Light will **not** pass through and you **cannot** see through.

    b. Translucent — Light will pass through but you **cannot** see through.

    c. Transparent — Light will pass through and you **can** see through.

6. Chemical — Reactions or resistance to various chemicals (such as acids, water, oxygen). Also, includes the acidity or alkalinity of the material and its resistance to corrosion or weathering.

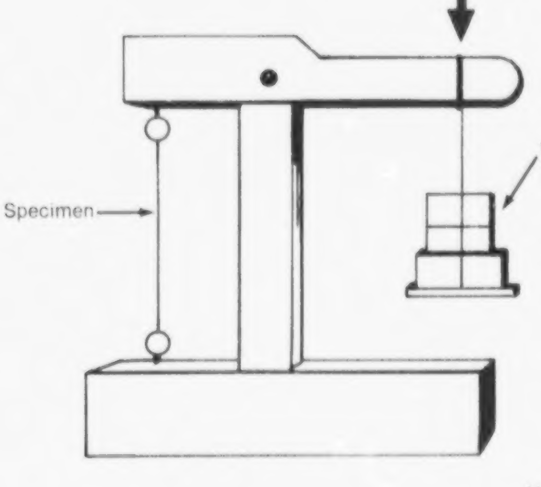
INFORMATION SHEET

V. **Testing of industrial materials** — Concerns the study of materials under specified conditions in order to know how they will perform in actual use. Testing is either destructive or nondestructive. (Transparencies 7 and 8 and Assignment Sheet #2)

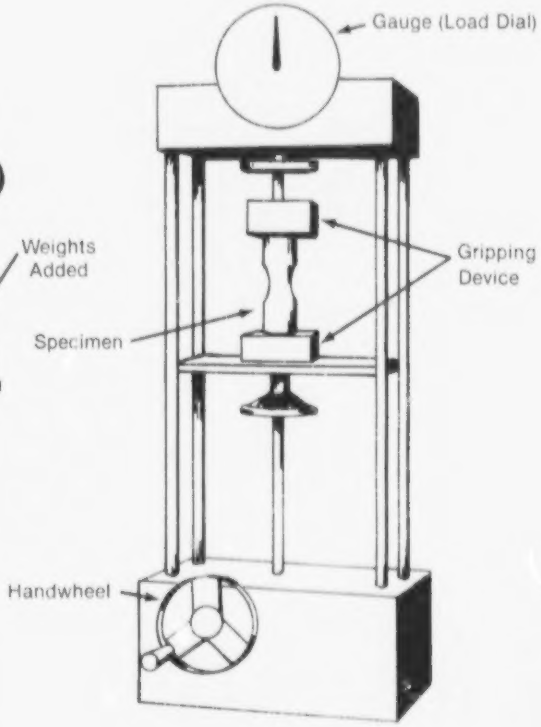
(NOTE: Standardized testing procedures for various materials have been developed by the American Society for Testing and Materials (ASTM) and other professional organizations.)

A. Destructive testing — Involves tests in which the specimen is damaged so it can not be used; therefore, only a sample of the material is tested instead of testing entire piece. It is usually done to test the mechanical properties of the materials. Some common destructive tests are listed below. (Transparency 7)

1. Tensile — Pulling forces applied to each end of the material. For example, rope and cables are tested for tensile strength. Usually a universal testing machine or a tensile testing machine is used to test tensile strength.



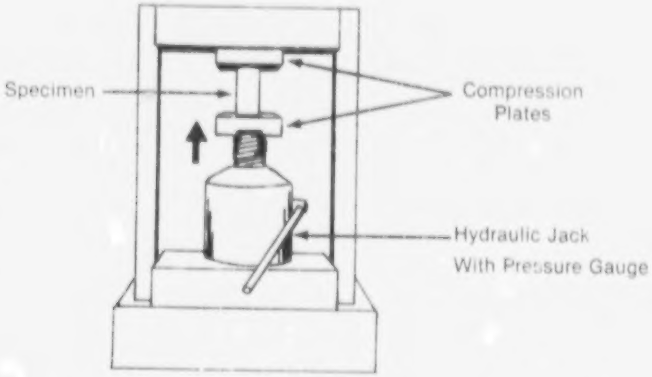
Tensile Testing Device for Thread



Tensile Testing Machine

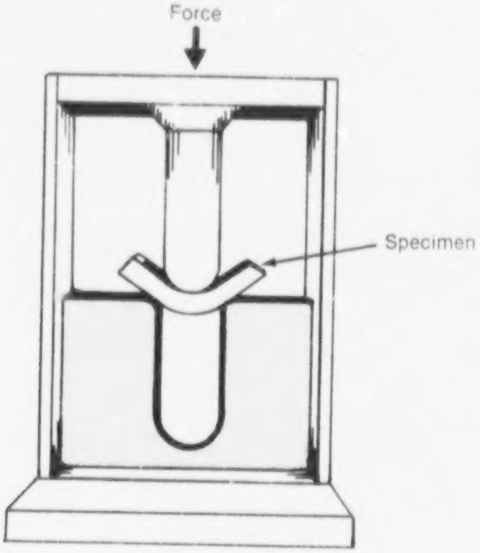
INFORMATION SHEET

2. Compression — Pushing forces applied to each end of the material. For example, chair legs or walls of buildings need to have compression strength. A universal testing machine or compression testing machine is used to measure the compression strength of materials.


Specimen
Compression Plates
Hydraulic Jack
With Pressure Gauge

Compression Testing Machine

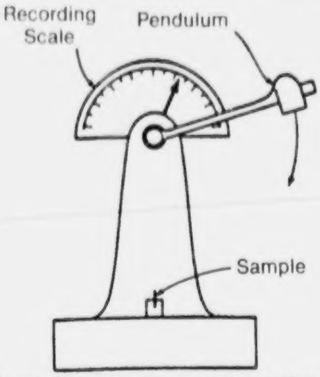
3. Bend — Test to see how much force (in one direction) is required to bend material and cause it to break. The stiffness of material and quality of joints (e.g. welded butt joints) are tested this way. Special fixtures and bend testing machines are used in this test.


Force
Specimen

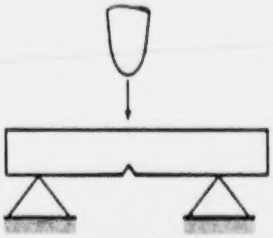
Bend Testing

INFORMATION SHEET

4. Impact — Sudden forces such as a hammer blow or dropped weights are used to test the toughness of the material. A material like glass may be hard but not tough. Special impact testing machines are used to accurately test the material.



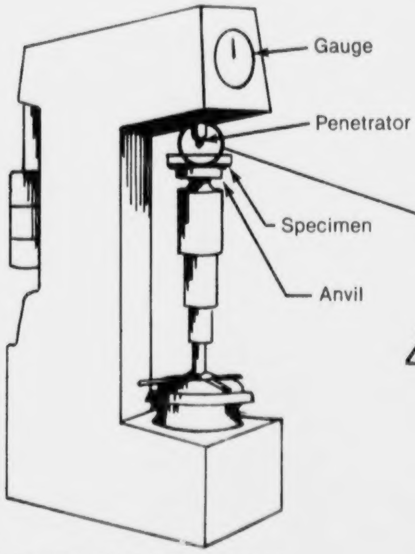
Machine for Charpy and Izod Tests



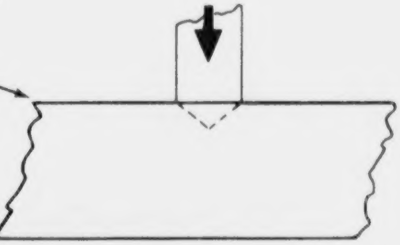
Drop Weight Test

From Kenneth Budinski, *ENGINEERING MATERIALS: Properties & Selection*, 2e (c) 1983, p. 31. Reprinted by permission of Prentice Hall, Inc., Englewood Cliffs, New Jersey.

5. Hardness — Tests the ability of the material to resist indentation (denting), abrasion (scratching), and wear (rubbing). For example, cutting tools need to be harder than the material to be cut. Common tests for hardness include the Rockwell hardness test, the Brinell hardness test, a file test, and Moh's scale of hardness (rocks and minerals).



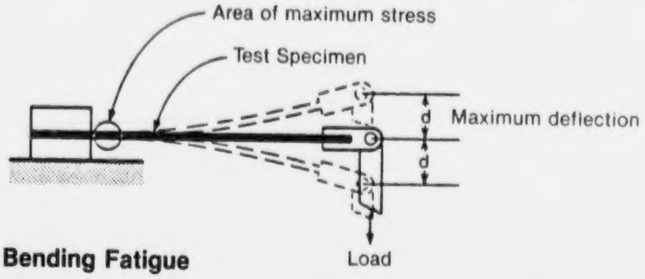
Rockwell Hardness Tester



Close-up of Penetrator Penetrating Specimen

INFORMATION SHEET

6. Fatigue — Tests measure the endurance of materials as they are subjected to repeated changes in loading. For example, the hinge life of a one-piece plastic hinge can be determined this way.



Typical Test Setup for Bending Fatigue

From Kenneth Budinski, *ENGINEERING MATERIALS: Properties & Selection*, 2e (c) 1983, p. 32. Reprinted by permission of Prentice Hall, Inc., Englewood Cliffs, New Jersey.

(NOTE: Many other tests can be performed on materials to tests their properties. Remember: If the test specimen can not be used again, the tests would be considered "destructive.")

B. Nondestructive testing — Uses tests which do not damage the material or part; therefore, it can be used to test every part. It is commonly done to locate defects in materials and products, and is frequently associated with inspection. Some common nondestructive tests are listed below. (Handout #1 and Transparency 8)

1. Visual — This is the oldest and most widely used method of checking the quality of materials and parts. Visual methods are primarily used to identify surface defects such as cracks and porosity (holes caused by air entrapment). To aid in visual testing and inspection, a variety of substances are used to make defects more easily seen.

   Example: Liquid penetrant test ("spotcheck")

2. Radiographic — Uses electromagnetic rays to identify discontinuities in the material.

   Examples: Gamma ray and x-ray

3. Ultrasonic — The interruptions of sound waves signal the presence of a defect. This is similar to submarines and ships bouncing sound off the ocean floor to chart its bottom.

4. Magnetic — Parts or materials are magnetized. Breaks in the magnetic field attract iron particles which identify location of defect.

   Example: Magnetic particle test ("Magnaflux")

5. Electrical — Disruptions in the flow of current signal a defect.

   Example: Eddy current test

INFORMATION SHEET

VI. **Major factors for material selection** (Transparency 9 and Assignment Sheet #3)

A. Availability

1. On-hand — "Do we have it here?"
2. Regularly stocked item — "Is it something we can buy easily?"
3. Requires special ordering or processing — "Will it have to be specially made?"

B. Economics

1. Cost of buying the material — "How much?"
2. Quantities of material required (cheaper in larger quantities) — "How many are we required to buy?"
3. Anticipated service life — "How long will it last?" Disposable, hundreds of hours, years.
4. Ability to be processed (formed, separated, and combined). "Can we process it in our lab?"

C. Properties — The most important properties to consider when selecting a material for a product are those essential to the use of the product. These properties include both mechanical and characteristic properties.

D. Environmental effects — Include the effects the material has on the environment during its production, use as a product, and its disposal. Is the material toxic? Recyclable? Biodegradable? Does it deplete available resources or affect the environment in other ways (e.g. acid rain)?

VII. **Types of wood and their characteristics** (Transparency 10)

A. Hardwoods

1. Come from trees which have wide leaves (broadleaf) and are deciduous (shed their leaves once a year).

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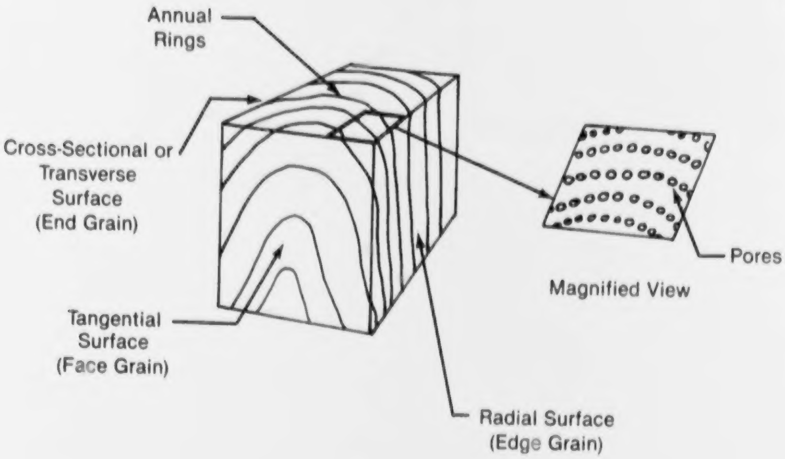
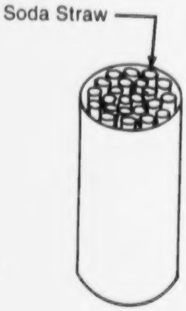
2. Hardwoods have vessels (large, hollow, tube-like cells which conduct nutrients), softwoods do not. When vessels are viewed in cross-section, vessels are called "pores." Hardwoods are called "porous" woods, softwoods are "nonporous."

   (NOTE: The three surfaces of a piece of wood are transverse, tangential, and radial.)


Annual Rings
Cross-Sectional or Transverse Surface (End Grain)
Tangential Surface (Face Grain)
Radial Surface (Edge Grain)
Pores
Magnified View

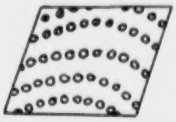


Structure is similar to soda straws in a can

3. Hardwoods are classified as ring porous or diffuse porous.

   a. Ring-porous hardwoods have distinct rings of large pores on their cross-sectional (transverse) surface.

      Examples: Oak, ash



   b. Diffuse-porous hardwoods have no distinct rings of large pores because the vessels stay the same size throughout the cross-sectional view of the annual rings.

      Examples: Birch, poplar

INFORMATION SHEET

4. Hardwoods are also classified as open-grained or closed-grained. This is determined by the size of the pores.

    a. Open-grained woods have large pores.

    Examples: Walnut, oak, ash

    b. Closed-grained woods have small pores.

    Examples: Maple, cherry

    (NOTE: In selection of woods for various applications, the porosity [open or closed grain] of the wood is an important consideration. For example, wood products used as surfaces for cutting food need to be closed-grained because food particles can get trapped in the surface of open-grained woods. Trapped food particles could possibly produce harmful bacteria. Also, it is easier to achieve a smooth finish with closed-grained woods.)

B. Softwoods

1. Come from trees with needlelike or scalelike leaves. Most softwoods are conifers (cone-bearing) and evergreens.

    (NOTE: Cypress and tamarack are exceptions.)

2. Softwoods do not have vessels or pores and are classified as "nonporous."

3. Softwoods typically have resin ducts as part of their cell structure; hardwoods do not.

    Examples: Pine, fir, spruce

    (NOTE: The classification of hardwoods and softwoods has nothing to do with the hardness or softness of the wood. Some softwoods such as fir are harder than some hardwoods such as poplar. It is the tree's origin and the structure and organizational pattern of wood cells which determine whether it is a hardwood or softwood. This also determines its properties and characteristic appearances.)

VIII. Ways to identify various woods (Handout #2)

A. Examination of surfaces and physical characteristics. This is the most common method of identifying various woods. Specifically, the following are examined:

1. Weight — Heavy or light (more scientifically, measure specific gravity)

2. Color of heartwood (earlier growth, closer to center of tree) and color of sapwood (more recent growth, usually lighter in color)

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3. Grain — Open or closed; patterns

4. Porosity — Non-porous, diffuse porous, or ring porous

5. Presence and pattern of certain wood cells

   Example: White oak has very long, distinctive medullary rays (cells which transport food horizontally from the center parts of a tree outward), while others may not.

B. Mechanical tests — Testing the mechanical properties

   Example: Hardness — Balsa is very soft while persimmon is extremely hard and has been used to make golf clubs.

C. Microscopic examination — Wood scientist examines thin wood specimen under microscope to determine species. Specific cell structures are the subject of examination.

   (NOTE: The official wood identification agency of the United States government is the Forest Products Laboratory in Madison, Wisconsin.)

IX. **Properties and characteristics of wood** (Handout #2)

A. Wood is relatively lightweight. This is explained by the fact that approximately half its volume is made of hollow cells. Wood has been referred to as an elastic honeycomb. Wood is a **natural composite material** composed of cellulose, wood fibers, and lignin (natural adhesive).

B. Every piece of wood is different from every other although most wood is readily recognized as wood. This is because each piece comes from a living plant that differs from other plants and species.

C. Moisture content/shrinkage

   1. Wood shrinks as it loses moisture and swells when it takes on moisture.

   2. Defects such as "checking" (splitting), warping, etc. can be attributed to moisture content and grain pattern.

   3. Moisture affects the mechanical and non-mechanical properties of woods.

   4. Some woods are likely to decay if in contact with moisture.

D. Thermal/electrical/magnetic properties — Wood is an insulator and is nonmagnetic.

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E. Acoustical

   1. Certain woods are noted for their acoustical properties and used to make musical instruments.

      Example: Violins, acoustical guitars, and pianos are made of wood. Sitka spruce is used to make piano sounding boards.

   2. Woods can also be remanufactured into modified wood products to reduce sound transmission through walls such as sound-deadening boards.

F. Miscellaneous properties

   1. Weight
   2. Hand tool workability
   3. Nail holding power
   4. Glue holding power
   5. Resistance to decay
   6. Toughness
   7. Strength
   8. Freedom from shrinkage

X. **Advantages of woods**

(NOTE: These vary from species to species.)

A. Lightweight

B. High strength-to-weight ratio

C. Good insulator — Thermal and electrical

   (NOTE: Wood 4" thick equals concrete 5' thick in insulative ability.)

D. Natural beauty — Some do not require finish or coating.

E. Easy to work by hand and power tools

F. Good performance vs. fire — Does not buckle or melt like steel or plastics

G. Long lasting — Some species are decay and chemical resistant.

   (NOTE: Some species decay rapidly and are subject to insect attack by termites, wood borers, etc.)

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H. Flexible and resilient while maintaining strength — Structures and products are subject to stresses.

I. Multiple uses — Wide range of applications

XI. **Forms of wood materials and how they are sold**

(NOTE: Wood is found in a variety of forms and sold respective to the form and grade.)

A. Wood is graded in a number of ways.

1. One can find wood that has very few knots, flaws, or defects, or one can find wood with many flaws.

2. It is important for the manufacturer, if using wood, to select stock that meets the needs of that particular production project.

B. Solid lumber — Boards, siding, and molding are solid pieces of wood.

1. Size — Solid lumber is specified according to thickness, width, and length in that order.

(NOTE: Some lumber is purchased just as it comes from the saw mill but most is dried and dimensioned (dressed) at the mill. The dried and surfaced dimensional (actual) size is smaller than the rough (nominal) size. For example, when a 1" thick piece of pine is dressed, it is 3/4" thick. Another example is nominal size 1 × 4 × 8′ — actual size 3/4 × 3 1/2 × 8′.)

2. Solid lumber (except molding) is sold by the *board foot*. (Molding is sold by the linear foot [so much money per length in feet, for example $.20 per foot].)

One board foot = 1" × 12" × 12"

$$\text{Board feet} = \frac{t'' \times w'' \times 1'}{12}$$

(NOTE: Grades and actual sizes differ for hardwood and softwood.)

C. Modified/engineered wood materials

1. These materials have been developed by man to overcome problems with solid lumber (for example, lack of stiffness or strength) and/or to make use of wood by-products and new harvesting techniques. These are examples of wood composite materials.

2. These materials are typically sold in 4 feet wide by 8 feet long sheets of different thicknesses (e.g. 1/4", 3/8", 1/2", 5/8", 3/4", 1"). Sheets are sold by the square foot. Each sheet would have 32 square feet. If the sheet costs one dollar per square foot, the sheet would cost $32.00.

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3. Examples of common modified/engineered wood materials:
    a. Plywood
    b. Fiberboard
    c. Standard particle board
    d. Flakeboard
    e. Waferboard
    f. Oriented strand board

XII. **Types of metals** (Handout #3)

A. Ferrous metals — Alloys which contain iron as a major element in their composition

Ferrous Element Example: Iron

Ferrous Alloy Example: Steel

B. Nonferrous metals — Metals which contain no iron except in very small quantities as impurities

Nonferrous Element Examples: Aluminum, lead, magnesium, tin, gold, zinc, copper, silver

Nonferrous Alloy Examples: Brass, pewter, bronze, solder

(NOTE: Ferrous and nonferrous metals could also be classified as base metals containing only one metal or as alloys which have several metals fused or blended together.)

C. Refractory metals — Metals with melting points over 3000°F. These are space age non-ferrous metals.

Refractory Metals Examples: Titanium, tantalum, beryllium, tungsten, columbium

XIII. **Metals identification and designation**

(NOTE: Metals may look very similar to the observer, but be very different. It is important to be able to distinguish between metals by various methods of designation and identification.)

A. Physical appearance

1. Color (sight)

    Example: Brass is yellow in appearance

2. Fracture (grain structure)

    Example: Gray iron is gray in appearance when fractured because graphite (pencil lead) is in the free state. It will get on your hands.

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B. Flame tests — As metals are subjected to heat, their appearance may change

Example: Polished steel changes from silver in appearance to blue, to red, to yellow as it is heated to higher and higher temperatures.

C. Number system — Number systems have been developed to identify the basic composition of casting alloys and wrought (formed) metals.

Example: 1090 steel (SAE/AISI steel designation)
7024 aluminum (Aluminum Association designation)

These numbers are stamped or printed on the metals.

D. Color code for steel — The ends of steel are painted on one end at the steel mill. The color indicates the composition. This is not standardized from steel mill to steel mill.

E. Spark testing — Each kind of steel and iron produces a different color and volume of sparks when it is put to a grinding wheel.

F. Tests of properties

1. Hardness ("file test")

Example: Soft materials (e.g. lead) are filed more easily than hard materials (e.g. steel).

2. Weight

Example: Aluminum is approximately ⅓ the weight of steel

3. Magnetic tests

Example: Iron and steel are attracted by a magnet, aluminum is not.

4. Thermal and electrical tests

Examples: Aluminum conducts heat and electricity better than steel. Lead melts at lower temperatures than aluminum.

XIV. Properties of metal

A. Opaque

B. Conductor of heat

C. Conductor of electricity

D. Reflective when polished

E. Expands when heated

F. Contracts when cooled

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XV. **Forms of metal materials and how they are sold**

- A. Ingot — Form of metal used for casting
- B. Wrought — Form of metal used in other methods of production
  - 1. Primary forms
    - a. Slabs — Minimum 36 sq. inches in cross section
    - b. Blooms
    - c. Billets
  - 2. Secondary forms (Transparency 11)
    - a. Sheet/plate — A sheet is less than ¼" thick, while a plate is ¼" or thicker.
    - b. Profile (end-view) shapes
      - 1) Rod ("round")
      - 2) Tubing — Square, round, etc.
      - 4) I-beam
      - 5) Angle
      - 6) Channel
      - 7) Bar (also called "band iron", flat)
      - 8) Hexagon
      - 9) Octagon
      - 10) Others — There are many other profile shapes.
- C. How they are sold
  - 1. Ingot metal is sold by weight.
  - 2. Secondary forms are typically sold by weight, foot, or piece.

XVI. **Types of plastics** (Transparency 12)

- A. Thermoplastics — Are heat softened, shaped, and cold hardened, and can be reheated and reshaped again and again; these plastics are recyclable.

  Analogy: Like candle wax or butter

  Examples: Polyethylene, polyamide (nylon)

INFORMATION SHEET

B. Thermosets — Set in permanent shape by heat and pressure, and will not resoften; these plastics are not recyclable.

Analogy: Hardboiling an egg; baking a cake

Examples: Epoxy, phenolic resins

XVII. Plastics identification

A. Nondestructive tests or checks

1. Note use of the plastic.

   Example: Milk bottles are made of polyethylene.

2. Note process used to produce the plastics product.

   Example: Rotational molded product indicates a thermoplastic.

3. Sight test — Appearance compared to description of common plastics

   Example: Acrylic is clear as glass.

4. Smell (cold) test — Scratch or sand edge and smell; compare to description.

   Example: Polyethylene smells like candlewax.

5. Feel test — Scratch it; hit it and listen for ring; feel it; compare to description.

   Example: Polystyrene is hard, smooth, and has a metallic ring.

6. Bend test — Bend plastic at room temperature and compare to description.

   Example: Polypropylene is flexible in thin sections, one-piece hinge material

B. Destructive tests

1. Softening point test — Thermoplastics soften, and different types soften at different temperatures; thermosets do not soften.

2. Burn tests (thermoplastic) — Does it ignite easily? Color of flame (base and tip of flame)? Characteristics of smoke, soot? Drips? Smell? Self-extinguishing?

   Example: Polyethylene ignites easily; burns rapidly with blue flame and yellow top; burn area swells and becomes clear as it melts and drips; smoke is white; smells like paraffin candle wax; not self-extinguishing.

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3. Solubility test — Plastics are tested with various solvents to see how they dissolve.

   Example: Acrylic is soluble in acetone, benzene, and toulene, while polyethylene is insoluble in all three.

4. Specific gravity — Relationship of the weight of plastics to water. Most plastics are heavier than water and sink, while a few float.

   Example: Polyolefins (polyethylene, polypropylene, etc.) float and have a specific gravity of 0.91-0.97. Polypropylene is the lightest plastic.

XVIII. **Properties of plastics** (Handout #4)

(NOTE: The properties of plastics vary greatly from family to family. A family of plastics is a group which is chemically the same. Plastics **may** exhibit the following properties.)

A. Softness (flexibility)

   Example: Polyurethane — pillow

B. Hardness (stiffness, rigidity)

   Example: Phenolics, epoxy

C. Impact strength

   Example: Polycarbonate — safety glasses

D. Electrical insulation

   Example: Vinyl coating on plier handles

E. Heat insulation

   Example: Polystyrene foam — Styrofoam® coats

F. Temperature resistance

   Example: Silicone seals

G. Elasticity

   Example: Silicone

H. Low friction

   Example: Polytetrafluorethylene — Teflon® non-stick surfaces

I. Transparency

   Example: Acrylic — Plexiglas® windows

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J. Ability to be permanently colored

Example: Melamine* dinnerware

K. Low melting point

XIX. **Forms of plastics materials**

A. Molding compounds — Powders, pellets, preformed shapes

Example: Polyethylene powders for rotational molding

B. Adhesives — Glues, cements, and caulks for bonding materials

Example: Polyvinyl acetate (Elmer's White Glue), epoxy, casein, silicone caulk

C. Dimensional and profile shapes — Produced by extrusion

Examples: Rods, tubes, bars, sheets

D. Films — Less than 0.010 inch thick "sheet"

Examples: Plastic bags, photographic film

E. Filaments and fibers — Single, slender shafts of plastic

Examples: Monofilament fishing line; woven fabrics (polyester shirts)

F. Casting compound — Syrupy liquids, or solid plastics melted and cast

Example: Polyester resin for encapsulating an insect or coin in clear plastic

G. Coatings — Paint, plastisol dispersions

Examples: Acrylic paints; plastic coated (vinyl plastisol) plier handles

H. Foams or cellular forms — Expanded plastics; insulative

Examples: Open-cell polyurethane - pillow, mattress (sponge-like)
Closed-cell polystyrene - styrofoam football (buoyant)

(NOTE: Plastic forms may be sold by weight, volume, or piece. Some profile shapes are sold by the foot or square foot.)

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XX. **Types of earth materials** (Handout #5)

A. Cement and concrete

1. Cement — An adhesive paste which coats the surfaces of aggregates (sand and gravel) and binds mixture into a rocklike mass as it hardens through chemical action with water (hydration).

2. Concrete — Is the resulting rock-like, one-piece mass from combining cement with aggregates and water.

B. Glass — A ceramic composed largely of silica ranging from opaque to optically clear, hard, and relatively non-porous

C. Rock and stone

1. Rock — A concretion (solidified mass) of earthy or mineral matter of inorganic composition and natural in origin. The solid portion of the earth's crust. Rocks are divided into the following three categories based upon their formation.

a. Igneous — Molten masses underwent different pressure and cooling changes to produce rock of varying composition.

b. Sedimentary — Rocks that have formed from deposits of crumbled rock, and material settling from decomposed rock, animals, and plants to build up on the bottoms of lakes and rivers. Located close to earth's surface.

c. Metamorphic — Are either sedimentary or igneous rocks transformed or changed (metamorphosed) to another composition from heat or pressure within the earth.

2. Stone — Smaller weathered rock fragments or those portions of rock shaped for building

D. Plaster — Finely ground, dehydrated gypsum rock which when mixed with water cures into a rigid, solid material

E. Ceramic

1. Ceramics — Products made chiefly from raw materials of an earthy nature (e.g. clay) which are subjected to a high temperature treatment during manufacture.

2. Clay — A decomposed granite-type rock which has plastic qualities due to its fine particle structure.

3. Cermets — Combination of *cer*amics and *met*als having some of the high refractory characteristics of ceramics and thermal-shock resistance and toughness of metals.

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XXI. Major parts of a composite

A. Filler — Provides the bulk (body) for the material in the form of layers, sheets, flakes, particles, or fibers

B. Matrix — Is the bonding agent for the filler, like an adhesive.

(NOTE: Wood, a bird's nest, and insect cocoons are examples of natural composites. Most engineering composites are man-made.)

XXII. History of composites

A. Egypt — Ancient builders added straw to clay to increase strength of bricks. Composite = straw + clay

B. Early Europeans — Strengthened plaster with the addition of hair from livestock.

C. Asia — Animal tendons, adhesives, silk, and wood were combined together to produce Thirteenth Century bows

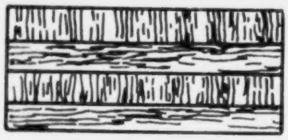
D. Medieval times — Laminated metals were used to produce swords and armor

E. Today — The development of composite materials continue to develop. Today's society benefits from such products as plywood, decorative laminated beams, fiberglass boats, radial and bias tires, graphite tennis rackets, etc.

(NOTE: Through this brief historical look at composites, it can be seen that man has seen the value of combining materials for a long time.

XXIII. Types of composite structures and their applications

A. *Layered (laminate) composites* — Layers of materials are bonded together and carry the load. These layers can include "honeycomb" panels high in strength with little weight since honeycomb is about 90% air.

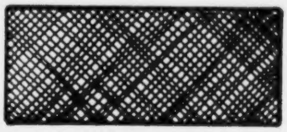


Examples: Plywood, hollow core doors, cardboard boxes, wings of aircraft ("honeycomb" covered with sheet aluminum), clad metals (coins—quarter, bi-metallic thermostat)

- Plywood — Modified wood panel product made of layers of wood glued together at 90 degrees to the layer above and/or below it.

INFORMATION SHEET

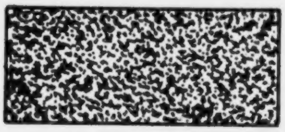
B. *Fiber (fibrous) composites* — Fibers form a matrix and carry the load in reinforcing a material.



Examples: Fiberglass, steel radial tires, straw-reinforced adobe bricks

- Fiberglass — Glass-reinforced plastic (GRP) increases strength of plastic.
- Fiberboard (Masonite®) — Very dense manufactured panel made from wood fibers. Fibers are held together by woods' natural glue (lignin).

C. *Particle (particulate) composites* — Particles are held in a matrix with the load shared by the particles and matrix.



Examples: Particle board, flakeboard, cermets, ceramics, concrete

- Particle board — Panel made from shavings, chips, or flakes of wood held together with a synthetic glue. Variations include standard particle board (smallest wood particles used), waferboard, flakeboard, and oriented strand board (strands or flakes are placed in certain direction). These have properties similar to plywood.
- Cermets — Particle composites produced through powdered metal (PM) technology.

  Examples: Silicon carbide crucibles, tungsten carbide inserts for saw blades and other cutting tools

- Concrete — The rock-like, one-piece mass which results from the combination of cement, aggregates (sand or gravel), and water.

XXIV. Advantages of composites

(NOTE: The following advantages focus on fiber reinforced plastic [FRP]. Fiberglass, glass reinforced plastic [GRP], is an example. However, some of these advantages also apply to wood-, metal-, and ceramic-based composites.)

A. *Improved properties* — Tensile strength, electrical properties, corrosion resistance, etc.

Examples: Thermocouplers

INFORMATION SHEET

B. *Increased dimensional stability* — Doesn't change shape as easily

Example: Plywood doesn't behave like solid wood

C. *Reduced overall cost* — Greater strength, less weight → less energy → less cost

Example: Composite parts replace steel parts on transportation vehicles such as aircraft and automobiles.

(NOTE: Some composites [e.g. graphite epoxy] are more expensive than metals [e.g. steel] initially, but can result in energy savings because of their lighter weight.)

D. *Increased chemical and corrosion resistance* — Doesn't rust

Example: Quarter panels in automobiles

E. *Increased toughness*

Example: Kevlar reinforcing fiber for "bullet proof" vests

F. *Decreased water absorption*

Example: Fiberglass boat

G. *Decreased thermal expansion*

Example: Turbine blades

H. *Improved mechanical dampening* — Doesn't vibrate as much

Example: Graphite epoxy tennis racket

I. *Improved design flexibility*

Example: High strength-to-weight ratios resulted in designs for the "Voyageur" spacecraft.

XXV. Other manufacturing materials in common use

A. Leather — Tough, organic material made from the skins of animals

Examples: Baseball gloves, boots

B. Rubber — An organic material (from rubber plants and trees) characterized by its high coefficient of friction, flexibility, and dielectric and elastomeric properties

Examples: Rubber tires, shoe ware, rubber bands

(NOTE: Synthetic rubberlike materials are also used to make many products that used to be made only from rubber.)

INFORMATION SHEET

C. Paper — All kinds of felted or matted sheets of fiber formed on a screen from water suspension. Materials such as water, wood pulp, waste paper, rags, and pigment are used in its manufacture.

Examples: Paperboard ("cardboard") boxes, paper bags

D. Textiles — Name applied to a family of fibers with similar chemical composition. These fibers are organic and may be natural (wool, cotton, silk) or synthetic (nylon, polyester) in origin.

MANUFACTURING MATERIALS AND SELECTION
UNIT III

HANDOUT #1 — NONDESTRUCTIVE TESTING METHODS

	Definition	Uses	Limitations
Liquid Penetrant Testing	Uses a penetrating liquid to seep into a surface discontinuity thus providing a visible indication.	Used on metal, glass, ceramics to locate surface discontinuities. Simple to use and does not require elaborate equipment.	Does not detect discontinuities beneath the surface of a specimen.
Magnetic Particle Testing	Uses electrical current to create a magnetic field in a specimen while magnetic particles indicate where the field is broken by a discontinuity.	Used on metal which can be magnetized (ferromagnetic) to detect surface or subsurface discontinuities. Simple to use and equipment is portable for field testing.	Cannot be used on metal which cannot be magnetized. Requires electrical power.
Radiographic Testing	Uses electromagnetic rays (x-rays and gamma rays) to penetrate materials, recording on film discontinuities in the material.	Used on metal stock or articles, as well as a variety of other materials to detect (and record on film) surface or subsurface discontinuities. Film provides a permanent record of the discontinuities.	High initial cost. Requires electrical power source. Potential safety hazard to personnel.
Eddy Current Testing	Uses an electrical current in a coil to induce eddy currents into a specimen. Indicators reveal discontinuities that alter the path of the induced currents.	Used on metals to detect surface and subsurface discontinuities, hardness, and thickness. Plating coating (non-metallic), and sheet thickness measurements.	Inspection depth limited to less than one inch. Does not give physical shape of discontinuities.
Ultrasonic Testing	Uses ultrasound to penetrate material, indicating discontinuities on an oscilloscope screen.	Used on metal, ceramics, plastics, etc., to detect surface and subsurface discontinuities. When automated, indications are recorded on paper, providing a permanent record. Also measures material thickness.	Moderately high initial cost. Requires electrical power source. Interpretation of test results requires high-trained personnel.

Courtesy of General Dynamics/Convair Division, San Diego, CA.

MANUFACTURING MATERIALS AND SELECTION
UNIT III

HANDOUT #2 — WOODS AND THEIR CHARACTERISTICS

HARDWOODS

Name	Relative Hardness	Color	Figure (grain pattern)	Grain	Hand Tool Work-ability	Nail Hold	Glue Hold	Decay Resist-ance	Tough-ness	Uses
Ash	Hard	Creamy white - light brown	High	Open	Difficult	High	Medium	Low	High	Baseball hats, skis, handles
Balsa	Very soft	White	Low	Closed	Easy	Low	Medium		Weak	Model building
Basswood	Soft	White	None	Closed	Easy	Low	High	Low	Low	Drawing boards
Beech	Hard	White - red. brown	Medium	Closed	Difficult	High	Medium	Low	Medium	Food containers
Birch, Yellow	Hard	White to dark red	Medium	Closed	Difficult	High	High	Low	High	Cabinets, spools
Black Cherry	Hard	Reddish brown	High	Closed	Difficult	Medium	High	Medium	High	Furniture
Gum, Sweet		Reddish brown	High	Closed	Medium	Medium	High	Medium	Medium	Lumber, veneer
Hickory	Hard	Grayish brown	High	Open	Difficult	High	Medium	Low	High	Handles, ladder
Mahogany, African	Medium	Reddish brown	Medium	Open	Medium	Medium	High	High	Medium	Furniture
Mahogany, Philip.	Medium	Reddish brown	Medium	Open	Medium	Medium	High	Low	High	Furn., paneling
Maple, North. Hard	Hard	White to reddish brown	Medium	Closed	Difficult	High	High	Low	High	Furn., flooring bowling pins
Oak, Red	Hard	Reddish tan to brown	High	Open	Difficult	High	High	Low	High	Furn., flooring millwork
Oak, White	Hard	Grayish tan	High	Open	Difficult	High	High	High	High	Furniture, boats
Poplar	Medium	White to brown w/greenish cast	Medium	Closed	Easy	Medium	High	Low	Medium	Furn., beginning wood projects
Sycamore	Hard	Reddish brown	Medium	Closed	Difficult	High	High	Low	Medium	Drawer slides, cheap furniture
Walnut	Hard	Chocolate brown	High	Open	Medium	Medium	High	High	High	Furn., gunstocks
Willow	Soft	Light green to brown streaky	Medium	Open	Easy	Medium	High	Medium	Low	Beginning wood projects

HANDOUT #2

SOFTWOODS

Name	Relative Hardness	Color	Figure (grain pattern)	Grain	Hand Tool Work-ability	Nail Hold	Glue Hold	Decay Resist-ance	Tough-ness	Uses
Cedar, Arom. Red	Soft	Red & white	High	Closed	Easy	Medium	High	High	Low	Chests, closet linings, novelty
Cedar, West. Red	Soft	Reddish brown	Low	Closed	Easy	Low	Medium	High	Low	Wood shingles, exterior siding
Fir, Douglas	Medium	Reddish tan	High	Closed	Med./ Hard	Medium	Hard	Medium	Medium	Construction lumber, plywood
Pine, Ponderosa	Soft	White to pale yellow	High	Closed	Easy	Medium	Medium	Low	Low	Lumber, millwork, boxes
Pine, West. White	Soft	Creamy white	High	Closed	Medium	Medium	High	High	Medium	Lumber, millwork, boxes
Redwood	Soft	Deep red	Low	Closed	Medium	Medium	High	High	Medium	Outdoor furnit., decks, siding

MANUFACTURING MATERIALS AND SELECTION
UNIT III

HANDOUT #3 — METALS AND THEIR CHARACTERISTICS

Name of Metal	Characteristics
FERROUS METALS	
Irons	
• Pig iron	Hard and brittle due to the high carbon content and its impurities (silicon, sulfur, phosphorus, and manganese).
• Gray cast iron	Gets its name from the carbon that is in a free state in the form of graphite flakes throughout the crystalline grain structure of the metal.
• White cast iron	Has its carbon in a chemically combined state called cementite which makes it so hard it cannot be machined, except by grinding. Its principal use is in the making of malleable iron.
• Ductile cast iron	Made from gray cast iron by adding magnesium alloys to make the carbon form nodules in the soft iron.
• Malleable iron	White cast iron that is heated at high temperature for a long period of time to free its carbon into globules and make it soft and machinable.
• Wrought iron	Has virtually no carbon because it has been burned out in a puddling furnace.
Carbon steels	
• Low-carbon steel (.05-.30% carbon)	Also known as machine steel, machinery steel, and mild steel. Used for forge work, rivets, chains, and machine parts that do not need great strength.
• Medium-carbon steel (.30-.60% carbon)	More difficult to bend, weld, and cut than low-carbon steel. Can be hardened and tempered by heat treatment. Used for bolts, shafts, car axles, rails, etc.
• High-carbon steel (.60-1.70% carbon)	Also known as carbon tool steel. Can be hardened to make metal cutting tools.
Steel alloys — The following metals may be added to steel to improve certain qualities	
• Nickel	Adds strength and toughness, shock and wear resistance, and rust resistance.
• Chromium	Gives steel a lasting, bright, silvery gloss that does not corrode and improves hardness and toughness.
• Manganese	Purifies, strengthens, and toughens the steel to make it withstand hard wear and strain.
• Molybdenum	Adds strength and hardness to steel and helps it withstand heat and blows.
• Tungsten	Produces a hard heat-resistant steel.
• Vanadium	Gives lightness, toughness, and strength to steel.

HANDOUT #3

Name of Metal	Characteristics
NON-FERROUS METALS	
Aluminum	Brilliant, silvery metal which is mined as bauxite. Weighs one-third as much as steel. Is a good conductor of heat and electricity.
Copper	Reddish-brown in color. Is an excellent conductor of electricity, second only to silver. Has high corrosion resistance, wear resistance, high temperature performance, and ductility.
Copper alloys	
• Brass	An alloy of copper and zinc which gives it a yellow color and keeps it from corroding as fast.
• Bronze	An alloy of copper and tin which makes it harder and longer-wearing than brass.
• German silver (also called nickel silver)	An alloy of copper, zinc, and nickel to substitute for silver in inexpensive jewelry.
Magnesium	Silver-white, light malleable metal much lighter than aluminum.
Lead	Bluish-gray, heavy, poisonous metal.
Tin	Shiny, silver metal used mainly for coating steel or iron to protect against rust.
Zinc	Bluish white metal used mainly for coating steel or iron to protect against rust.
Gold	Precious, heavy, bright yellow metal used for ornamental work, jewelry, coins, and dental fillings.
Silver	Precious, shiny, white metal used for jewelry, tableware, mirrors, and coins. Best conductor of electricity.
REFRACTORY METALS	
• Titanium	Strong as steel, but only half as heavy. Is bright, extremely corrosion resistant, withstands extreme temperatures, and can be machined easily.
• Beryllium	Has a weight strength ratio similar to that of high strength steel or titanium but is 33 percent lighter than aluminum. (NOTE: Beryllium was developed for highly specialized applications, but has evolved into use in products which have nuclear applications, and fabrication of lightweight aerospace structures.)
• Columbium	Resistant to radiation damages, fabricated by conventional processes, melts at 4380°F.
• Tantalum	Used in rocket nozzles and nuclear reactors where dependability at 2000°F is required.
• Tungsten	Melts at 6200°F, higher than any other known metal. Used as spark plug electrodes and as nonconsumable electrodes in welding (TIG or GTAW). Shaping is done by powder metallurgy.

MANUFACTURING MATERIALS AND SELECTION
UNIT III

HANDOUT #4 — COMMON PLASTICS

Type of Plastics	Form	Characteristics	Applications
THERMOPLASTICS			
ABS	Sheets	Tough, strong; resists most stains and chemicals	Luggage, cases
Acrylic	Rods, sheets, tubes	Excellent optical qualities; weather and heat resistant, strong	Signs, lenses, windshields
Cellulosics (Acetate)	Sheets, film	Great clarity, glossy; easily processed	Packaging
Fluorocarbons (Teflon)	Rods, tape, tubes	Chemical resistant, non-adhesive, low friction, high thermal stability	Non-stick coatings on metal, bearing plates, plumber's sealing tape
Polyamide (Nylon)	Sheets, powder	Very strong, self lubricating, high abrasion resistance	Gears, bearings, drawer guides
Polycarbonate	Sheets, powder	High impact strength, transparent	Safety glasses, "bullet proof glass"
Polyethylene	Film, powder, pellets	Non-toxic, lightweight, easily processed, resistant to most chemicals	Toys, housewares, squeezable bottles
Polystyrene (Hi-Impact)	Beads, foam, sheets	Variety of colors, easily processed, poor chemical resistance	Toys, model cars, housewares, insulation
Polyvinyl Chloride	Liquid, pipe, sheet, film	Abrasion and weather resistant, tough. Caution: Do not overheat	Shoes, raincoats, auto upholstery
THERMOSETS			
Epoxy - Plastic Steel	Liquid molding components	Very good adhesion qualities; weather resistant; high strength; good electrical properties; heat stable	Laminating for nose cones, aircraft bodies, and battery cases
Melamine - Formaldehyde (Meline)	Sheets, powder	Strong; hard to scratch; withstands high heat and moisture; full range of colors; odorless; tasteless; nontoxic; oil resistant; best whiteness retention	Dinnerware; table and counter tops
Phenolics - Phenol formaldehyde (Phenolic), Bakelite	Powder, sheets	Strong; hard to scratch; good heat and electric insulation; high resistance to moisture	Radio and TV cabinets; telephones; pot and utensil handles; electric outlets

HANDOUT #4

Type of Plastics	Form	Characteristics	Applications
Polyester - (fiberglass)	Liquids, fiber	Strong; hard to scratch; unaffected by water; good resistance to chemicals and heat	Bath tubs; boats; sport car bodies; patio roofing; fabrics
Polyurethane	Foams, liquids, sheets	Foamed plastic similar to rubber; very resilient, returns quickly to original shape after being wrung dry; light weight; heat resistant; good insulation	Used extensively as insulation for homes, bedding, cushions; seat cushions
Silicone - Silastic RTV	Liquid, caulks	Stable at high temperature and also at low temperature; resistant to weathering and oxidation; excellent electrical properties; water repellent; resistant to most gases, chemicals, and solvents	Waterproof waxes, polishes; greases; cosmetics; electrical insulators; release agents, low temperature mold material

MANUFACTURING MATERIALS AND SELECTION
UNIT III

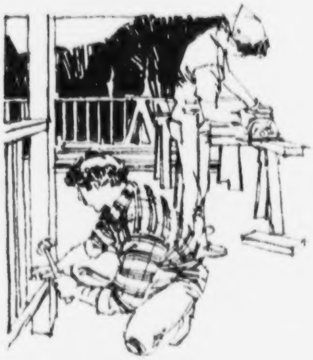
HANDOUT #5 — EARTH MATERIALS

Type of Earth Material	Characteristics and Uses
Concrete	Excellent compressive strength, durable; used for concrete statuary for exterior use, lawn furniture, planters, septic tanks, concrete pipe, wall panels, structural members
Glass	Excellent tensile strength, rigid and brittle material in solid form; however, glass fibers can be arranged and combined with plastic resins to form objects of high strength (fiberglass), heat and electrical resistance, chemical resistance (used as food and beverage containers), and excellent optical properties (light transmission)
• Soda lime	Cheapest of major types of glasses; used for windows
• Borosilicate	Able to handle high temperature; used for ovenware, laboratory equipment
• Lead alkali silicate	Excellent refractory; used for crystal glass for tableware
Rock and stone	Permanence of color and shape, impervious (little or no effect) to chemical attack, weathering, fire, unique in hardness, weight, rigidity
• Obsidian	Fine grain, volcanic glass
• Granite	Large crystals, very dimensionally stable; used for monuments, building blocks, steps, surface plates for precision measurement
• Shale	Used for clay products, ceramics
• Gypsum	Used for plaster
• Sandstone	Used for concrete aggregate; building stone
• Limestone	Soil conditioning, fluxing agent; building stone
• Slate	Closed-pore and rigid; used for roofing, chalkboard, steps, billiard table tops
• Marble	Closed-pore; decorative rock used in construction; statues and sculptures. Marble chips and dust mixed with resin to produce cultured marble products
• Quartz	Used in the form of quartz glass; noted for its transparency to ultraviolet radiation (quartz lighting)

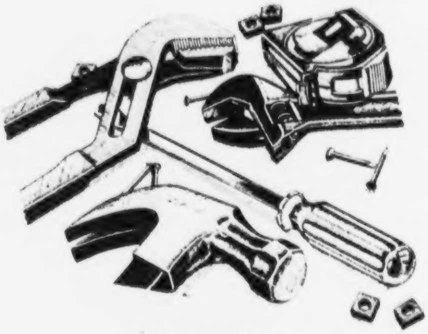
HANDOUT #5

Type of Earth Material	Characteristics and Uses
Plaster	Always expands while being processed (most other materials shrink); absorbs water because it is porous; rather hard and brittle (special plasters such as smoking plaster remains soft); fills all contours and surfaces when cast properly against them
• Metal casting plaster	Metal cast into plaster molds, excellent detail
• Molding/casting plaster	Slip cast clay products in plaster molds, and make plaster products (e.g. pottery plaster, plaster of paris)
• Building construction plaster	Sheetrock (drywall), plaster walls
• Hydrocal®	Hard tooling plaster, more dimensionally stable, pattern-making
• Ultracal® ®U.S. Gypsum trademark	Harder than Hydrocal, more dimensionally stable, pattern-making
Ceramics	Inorganic (therefore, chemically inert), hard, rigid, brittle, mechanically strong, excellent high voltage insulation, excellent high temperature refractory, nonflammable, fireproof, tasteless and odorless, inexpensive raw materials; reused indefinitely until fired
• Clay construction products	Brick, tile, sewer pipe, flues, sinks, toilets, etc.
• Refractory materials	Firebricks, furnace linings, jet engine parts, space shuttle tiles
• Abrasives and cutting materials	Silicon carbide and aluminum oxide used to produce grinding wheels and abrasive materials (sandpaper); ceramic inserts for cutting tools
• High voltage materials	Insulators, spark plugs
• Housewares	Porcelain and china dinnerware; pots and pans; statuettes, and novelty items
• Medical	Dentures

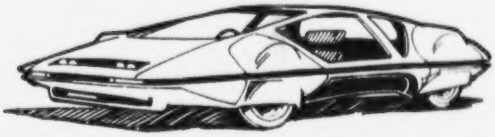
Common Manufacturing Materials



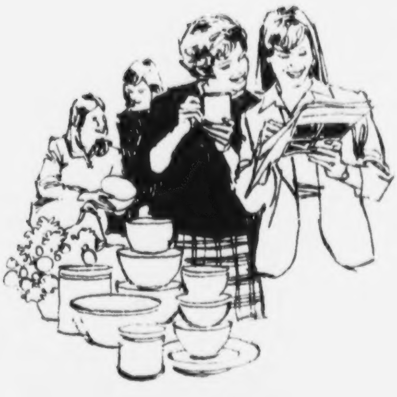
Woods



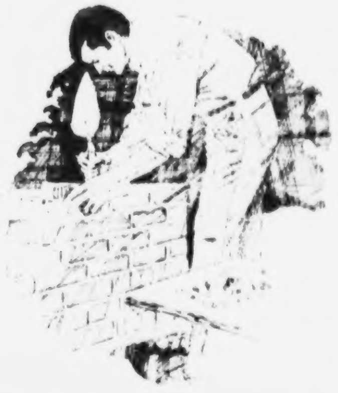
Metals



Composites



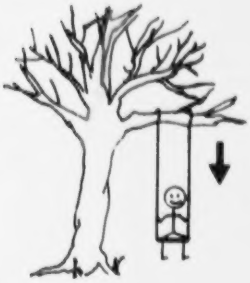
Plastics



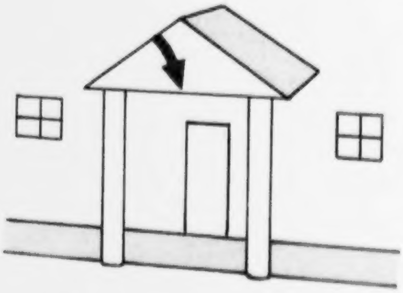
Earth Materials

Mechanical Properties

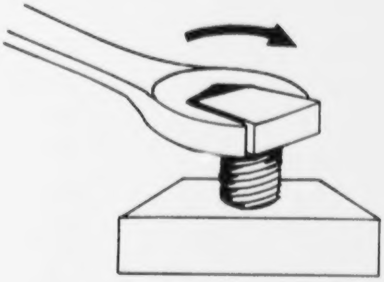
Strength



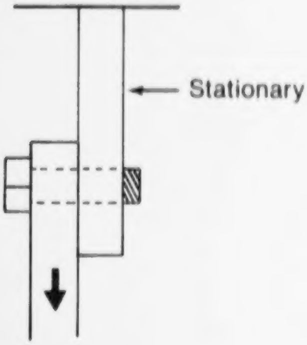
Tension
Ropes are being pulled upon.



Compression
The roof pushes down on the columns.

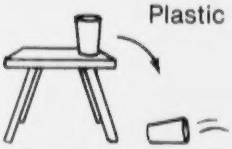


Torsion
Bolt is being subjected to twisting force.

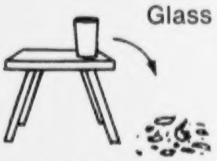


Shear
Bolt is being subjected to shearing forces.

Impact



Toughness



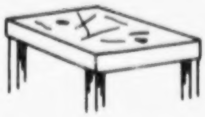
Brittleness

Mechanical Properties
(Continued)

Hardness

Table Tops

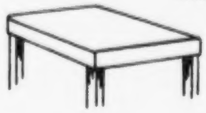
Wood



Scratched and
Dented

SOFT

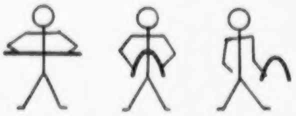
Steel



Still
Smooth

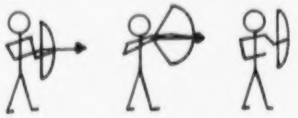
HARD

Ductility



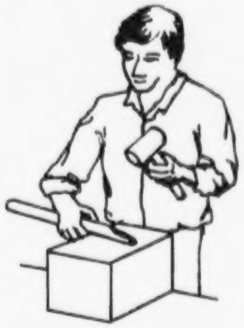
Rod bends but
doesn't break

Plasticity



Bow returns to
original shape

Elasticity

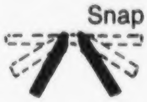


Rod hammered into
new shape

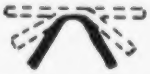
Malleability

Fatigue Strength

Low
(Breaks)



Polystyrene



Polyethylene

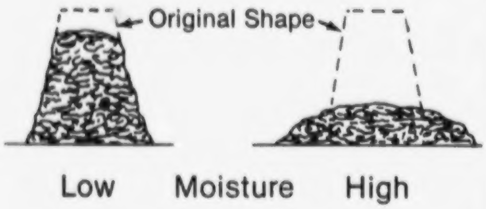
High
(Remains
usable)

After repeated back and forth bending

Characteristic Properties

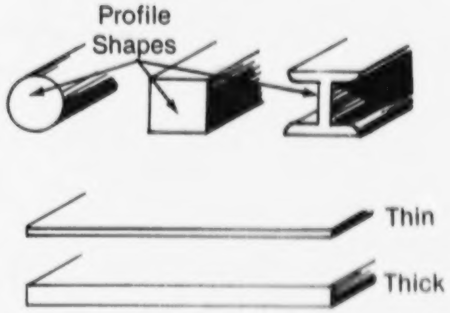
Physical/Dimensional

Moisture Content


Original Shape
Low
Moisture
High

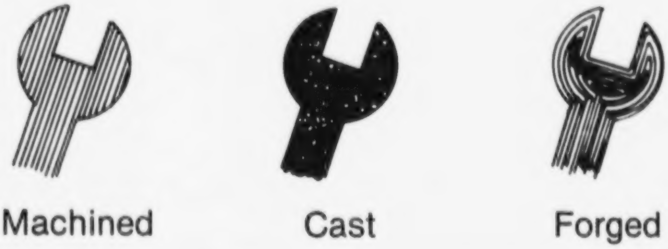
Slump Test of Concrete

Shape

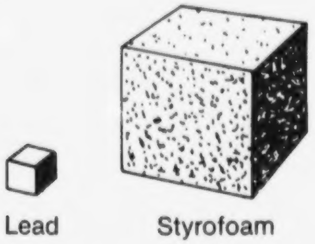

Profile Shapes
Thin
Thick

Structure

Grain

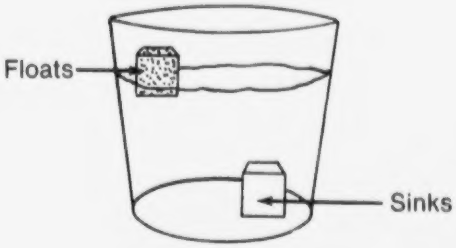

Machined
Cast
Forged

Density


Lead
Styrofoam

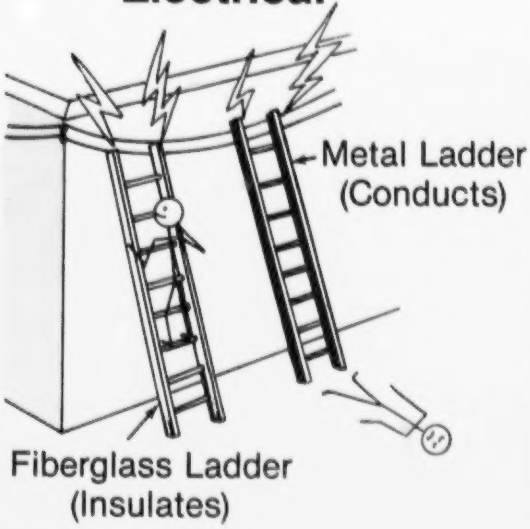
Both Weigh 1 Pound

Specific Gravity

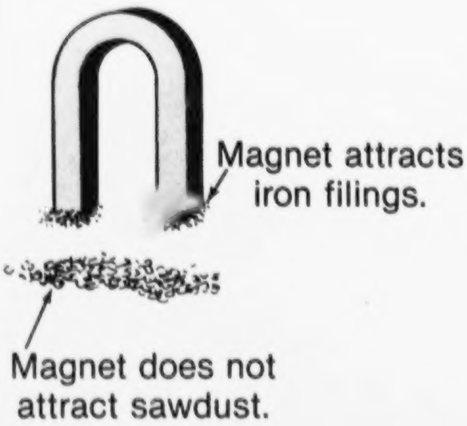

Floats
Sinks

Characteristic Properties
(Continued)

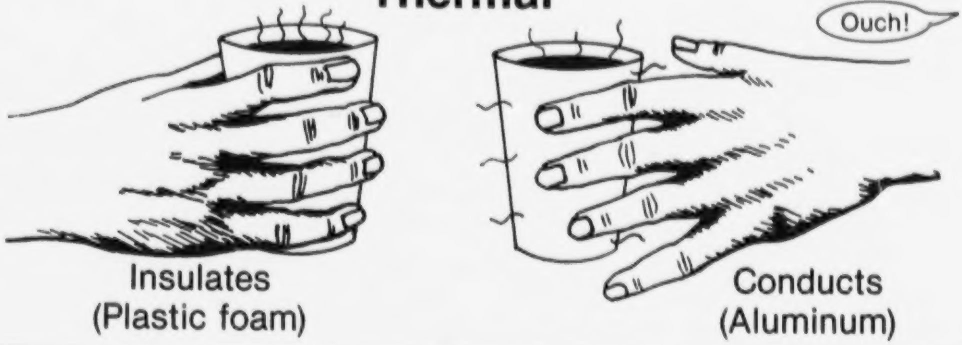
Electrical


Metal Ladder (Conducts)
Fiberglass Ladder (Insulates)

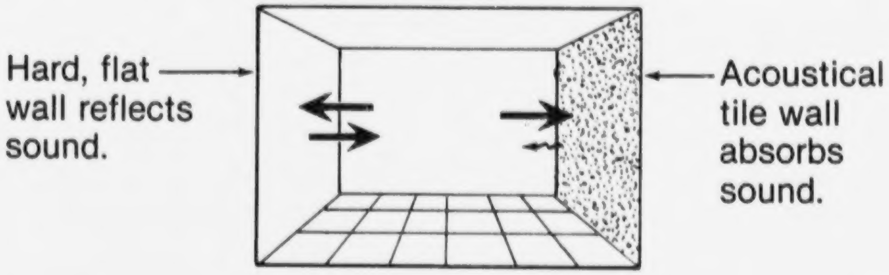
Magnetic


Magnet attracts iron filings.
Magnet does not attract sawdust.

Thermal

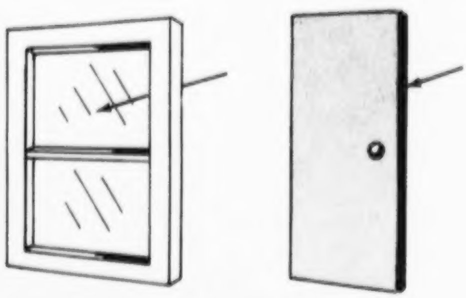

Ouch!
Insulates (Plastic foam)
Conducts (Aluminum)

Acoustical


Hard, flat wall reflects sound.
Acoustical tile wall absorbs sound.

Characteristic Properties
(Continued)

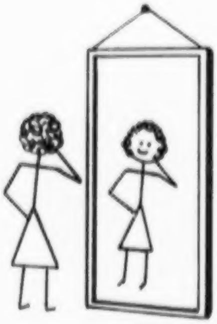
Optical



Transparent

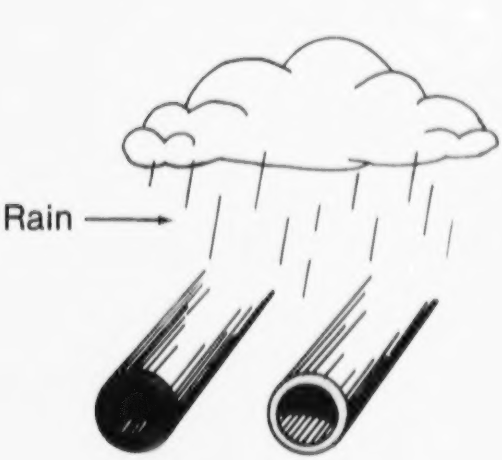
Opaque

Light Transmission



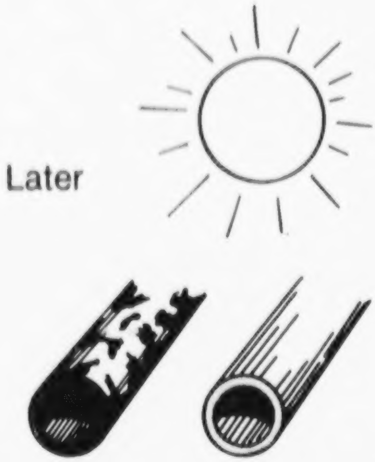
Reflection

Chemical



Steel

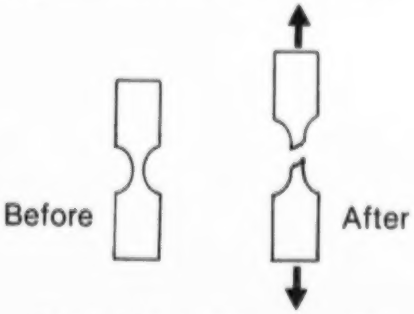
Aluminum



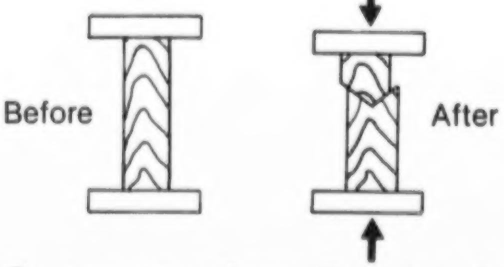
Rusted Steel
(Oxidation)

Aluminum

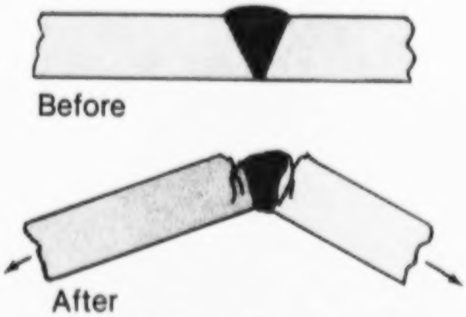
Destructive Testing
(Specimens Before and After Testing)


Before
After

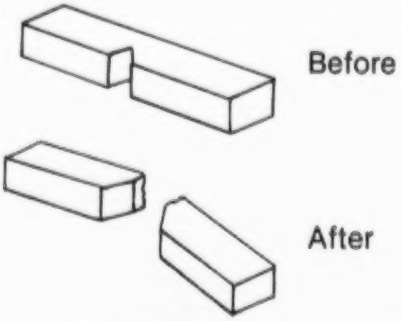
Tensile Strength


Before
After

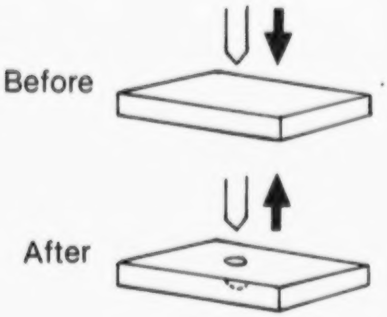
Compression Strength


Before
After

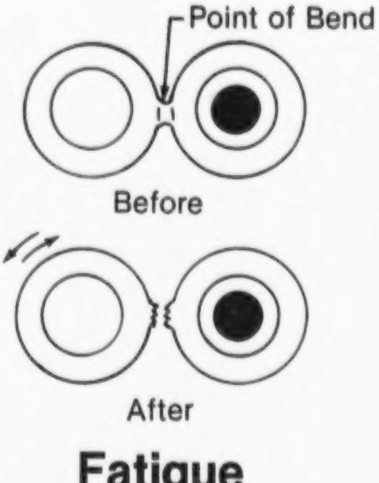
Bending


Before
After

Impact


Before
After

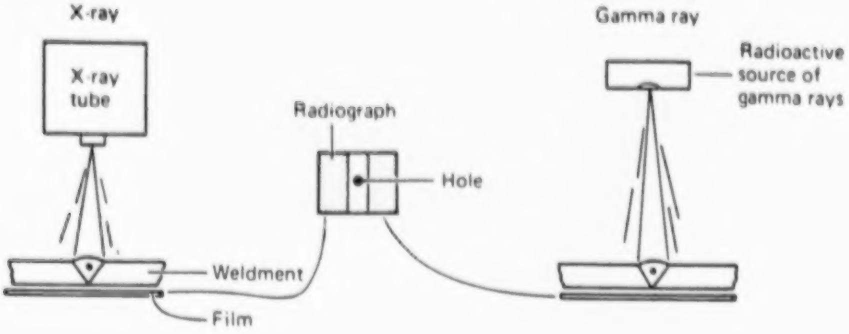
Hardness


Point of Bend
Before
After

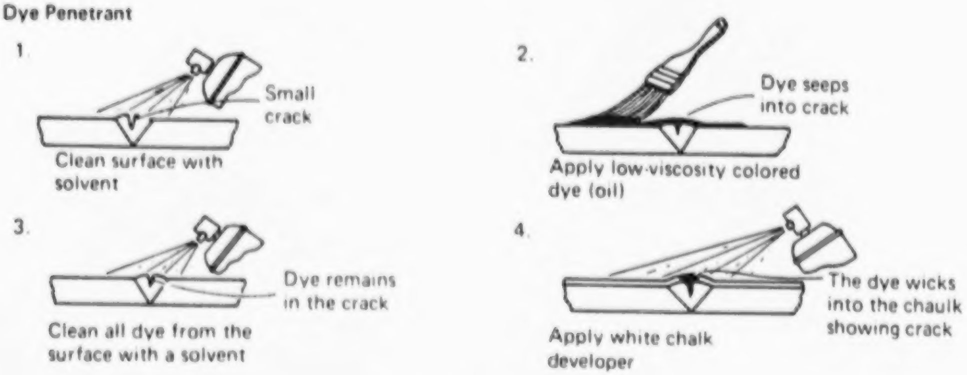
Fatigue

Nondestructive Testing

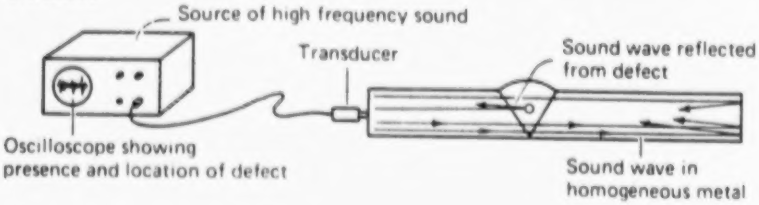
Radiography


X-ray
X-ray tube
Radiograph
Hole
Gamma ray
Radioactive source of gamma rays
Weldment
Film

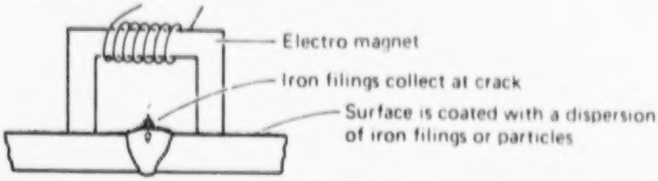
Dye Penetrant


1.
Small crack
Clean surface with solvent
2.
Dye seeps into crack
Apply low-viscosity colored dye (oil)
3.
Dye remains in the crack
Clean all dye from the surface with a solvent
4.
The dye wicks into the chaulk showing crack
Apply white chalk developer

Ultrasonic


Source of high frequency sound
Transducer
Sound wave reflected from defect
Oscilloscope showing presence and location of defect
Sound wave in homogeneous metal

Magnetic Particle

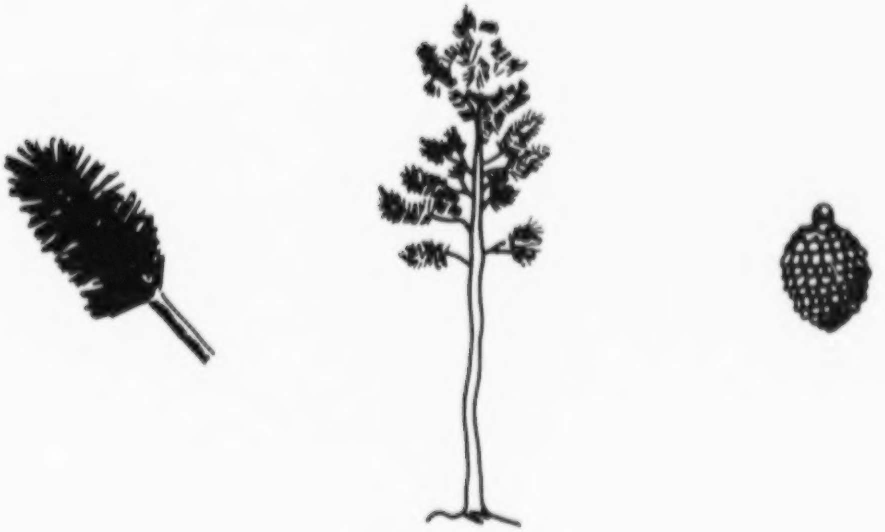

Electro magnet
Iron filings collect at crack
Surface is coated with a dispersion of iron filings or particles

From Kenneth Budinski, *ENGINEERING MATERIALS: Properties & Selection*, 2e (c) 1983, p. 431. Reprinted by permission of Prentice Hall, Inc., Englewood Cliffs, New Jersey.

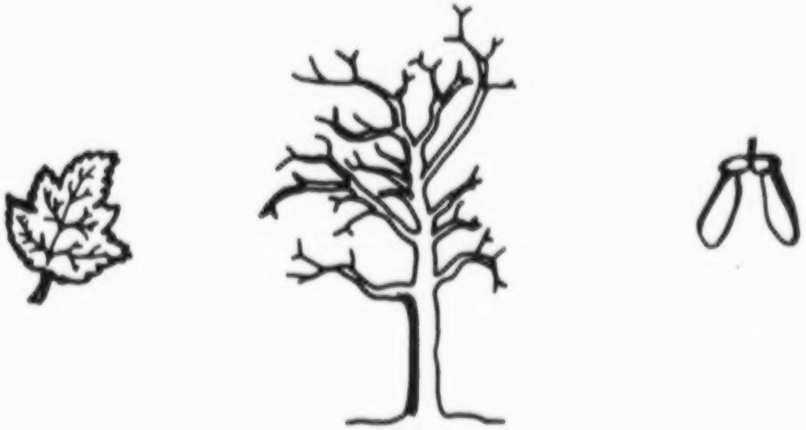
Major Material Selection Factors

- **Economics**
  - Cost to buy
  - Quantity required
  - Anticipated service life
  - Ability to be processed
- **Availability**
  - On hand?
  - Regularly stocked item
  - Special order or processing
- **Properties**
  - Mechanical
    - Tensile
    - Compression
    - Shear
    - Torsion
    - Impact
    - Hardness
    - Ductility
    - Plasticity
    - Elasticity
    - Malleability
    - Fatigue
    - Others
  - Characteristics
    - Physical
    - Dimensional
    - Electrical
    - Magnetic
    - Thermal
    - Acoustical
    - Optical
    - Chemical
- **Environmental Effects**
  - Deplete available resources
  - Impact on environment
  - Recyclable
  - Others

Types of Wood



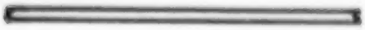
Softwoods
From Coniferous Trees



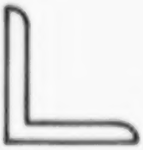
Hardwoods
From Deciduous Trees

TM 10

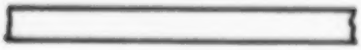
Common Metal Shapes



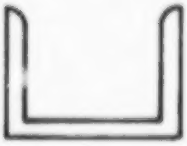
Sheet



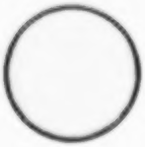
Angle



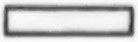
Plate



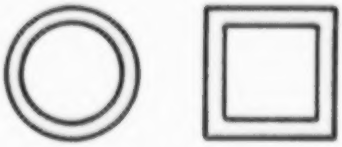
Channel



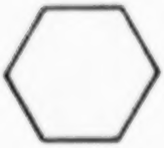
Rod



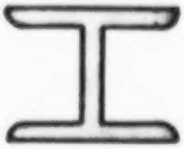
Bar



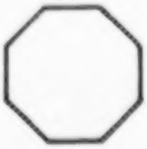
Tubing



Hexagon

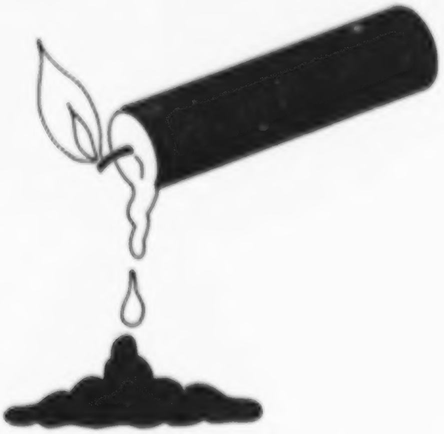


I-Beam



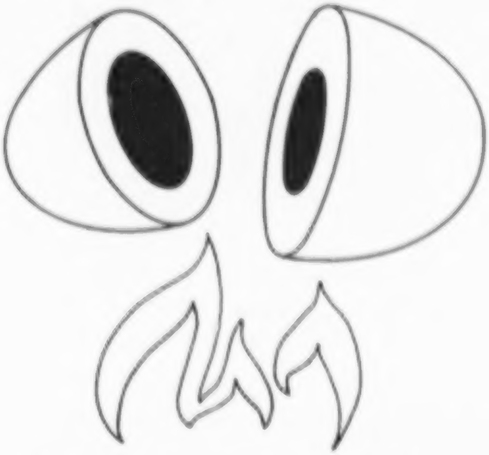
Octagon

Types of Plastics



Thermoplastic

These plastics become soft when exposed to sufficient heat and harden when cooled. Process can be repeated.



Thermosetting

These plastics become set into permanent shapes when heat and pressure are applied to them during the forming process. Reheating will not soften these materials.

MANUFACTURING MATERIALS AND SELECTION
UNIT III

ASSIGNMENT SHEET #1 — COMPLETE CROSSWORD PUZZLE OF "MANUFACTURING MATERIALS" TERMINOLOGY

Directions: This crossword puzzle reviews some of the terminology discussed in this unit. Carefully review the clues and fill in the appropriate blanks. This activity should be done in *pencil.*

Evaluation: There are 25 answers to be completed; therefore, each correct answer is worth four points. The instructor will provide the grading scale for this assignment. A minimum score of 80% is required for this activity.

Correct	Score
25	100
24	96
23	92
22	88
21	84
20	80

ASSIGNMENT SHEET #1

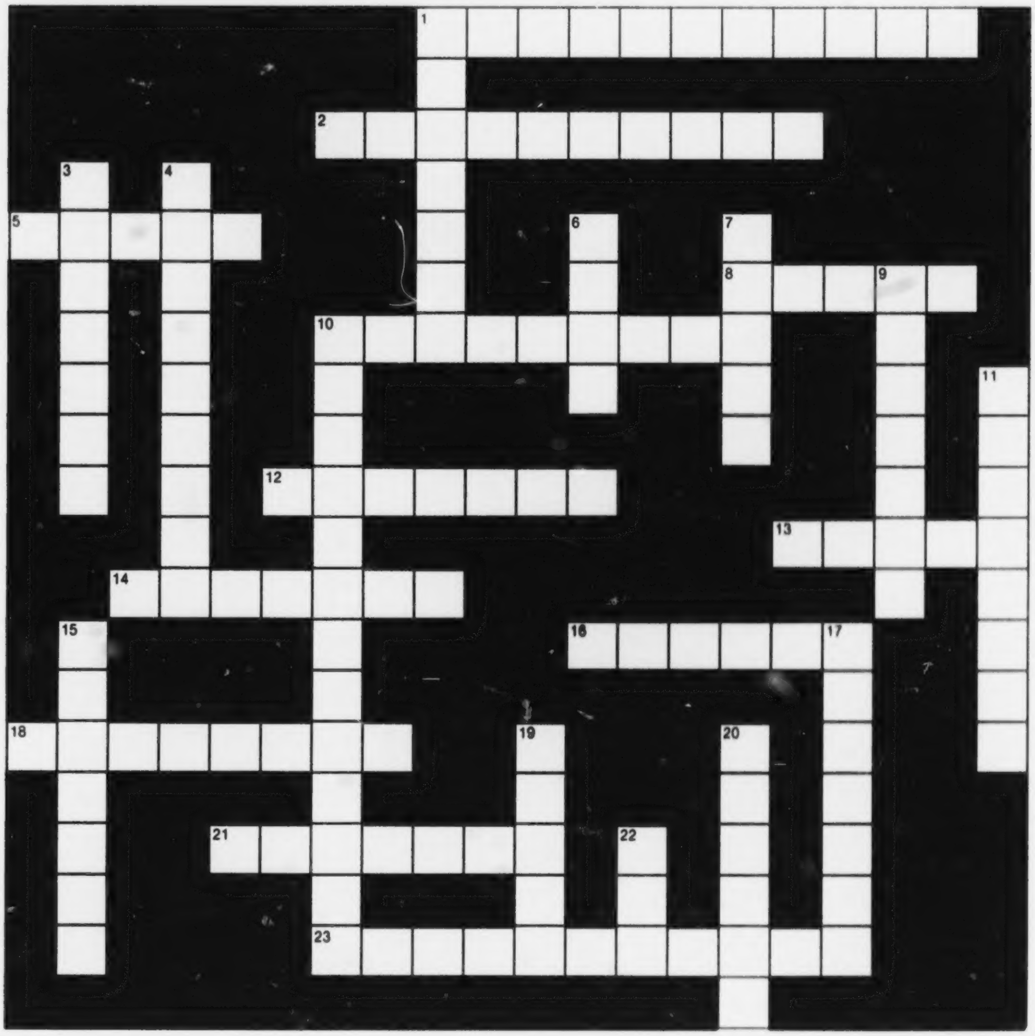
ACROSS CLUES

1. Type of testing in which the specimen is damaged so it can not be used.
2. Type of properties that indicate how a material reacts to loads and forces being applied to it.
5. Two or more elements, one of which is a metal.
8. Materials that are nonmetallic; inorganic substances that are extracted from the planet crust.
10. Plastics that set in permanent shape by heat and/or pressure and will not resoften.
12. Materials derived from living organisms: wood, leather, paper, plastics.
13. Material that retains its shape, is not very compressible, and has a definite melting point.
14. Metals in which iron is the major ingredient such as gray iron or steel.
16. The ability to withstand a sudden shock, such as a hammer blow, is called ______________ strength.
18. Substance which stock is made or composed of; will be processed into a finished product.
21. To absorb repeated stress, such as constant bending or flexing, is called ______________ strength
23. Material's ability to withstand a squeezing force is called ______________ strength.

DOWN CLUES

1. Material's ability to be bent, twisted, stretched, or changed in shape is said to be ______________ .
3. A substance that cannot be divided into other kinds of substances.
4. Two or more materials combined to form properties superior to their individual properties.
6. A natural composite composed of cellulose fibers and lignin (a natural adhesive).
7. Opaque material that is conductive of heat and electricity.
9. Material's ability to withstand a pulling force is called ______________ strength.
10. Plastic that is heat softened and cold hardened, and can be reheated and reshaped.
11. Material's resistance to penetration, indentation, and abrasion.
15. Man-made material that is capable of being formed by heat and/or pressure; a petroleum product.
17. Ability to withstand twisting force such as in tightening a bolt with a wrench.
19. Ability to resist one surface sliding over another such as in the way scissors cut material.
20. Fluid material that takes shape of its container, and is not very compressible.
22. Material that takes shape of its container, and is compressible.

ASSIGNMENT SHEET #1


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

MANUFACTURING MATERIALS AND SELECTION
UNIT III

ASSIGNMENT SHEET #2 — TEST MATERIALS AND PRODUCTS

NAME ______________________________ SCORE __________

The properties of materials and their processing characteristics are important considerations in their selection for use in manufacturing a product. Engineers and product designers depend upon having accurate information about the characteristics and strengths of materials.

Directions: Your instructor will assign a particular *material* or *property* for you to test from the following combinations:

Material	**Description or Form**	**Property**
Wood		Compression strength
Metals	Welding rod	Thermal conductivity
Plastics	Sheet	Fatigue strength
Earth		Hardness (abrasion or indentation)
Composite	Glued joint	Strength of adhesive

A. Design and sketch a simple testing device you could make with the existing tools and equipment in your school laboratory. Use information sheets and resources to obtain ideas.

B. Plan the procedure you would use to test the material.

   1. Size of specimen (use three of same kind)

   2. Amount of energy, force, or distances involved in test

   3. How results will be measured

C. Build the simple testing device under your instructor's supervision.

D. Test the material and record results. (Use three specimens of same kind.)

E. Briefly describe the outcome of your tests.

F. Evaluate your testing method.

ASSIGNMENT SHEET #2

Sketch of testing device

Testing procedure — Note size of specimen, amount of energy, etc., and measurement of results.

____

____

____

____

____

____

____

____

ASSIGNMENT SHEET #2

Outcome of tests

1. How did your materials perform? ____________________________________

   ____

   ____

   ____

2. Did each of the three specimens perform alike? ☐ Yes ☐ No

Evaluation of testing device

1. Did it perform the way you planned? Explain.

   ____

   ____

   ____

   ____

2. What would you do to improve your testing device?

   ____

   ____

   ____

   ____

   ____

Evaluation Criteria: Student will be evaluated on ability to follow instructions evidenced by the completion and thoroughness of this assignment.

MANUFACTURING MATERIALS AND SELECTION
UNIT III

ASSIGNMENT SHEET #3 — SELECT AND IDENTIFY MATERIAL USED FOR MANUFACTURING PRODUCTS

NAME ______________________________ SCORE __________

Product designers must select materials which have the properties necessary for a product to be useful. For example, if your classroom chair were made of balsa wood, it would collapse very easily as well as be rather expensive. Your assignment is two-fold.

For Part A, you are to identify products in school or around home. Determine what material was used to make them, and why it was chosen (based upon properties).

For Part B, you are to use the information sheets, handouts, and your personal knowledge in determining what material should be used to make each of the products found on Table B.

Directions: Complete Tables A and B as accurately as possible. Use all of the resources (resource people and written records) you have available to assist you in completing the assignment. Be sure to record all information requested.

Evaluation: You will be evaluated on the completeness, accuracy, and neatness of this assignment.

ASSIGNMENT SHEET #3

Part A — Material Selection for Five Products

No.	Product Name	Location	Material Used	Reason Material Was Chosen (Note properties and criteria)
Ex.	Plastic milk bottle	Refrigerator at home and at store	Polyethylene	Can be formed into a milk bottle
1				
2				
3				
4				
5				

Table A

ASSIGNMENT SHEET #3

Part B

Your teacher will assign you five (5) products. You are to select materials that are appropriate for manufacturing these products and note the reason for selecting them.

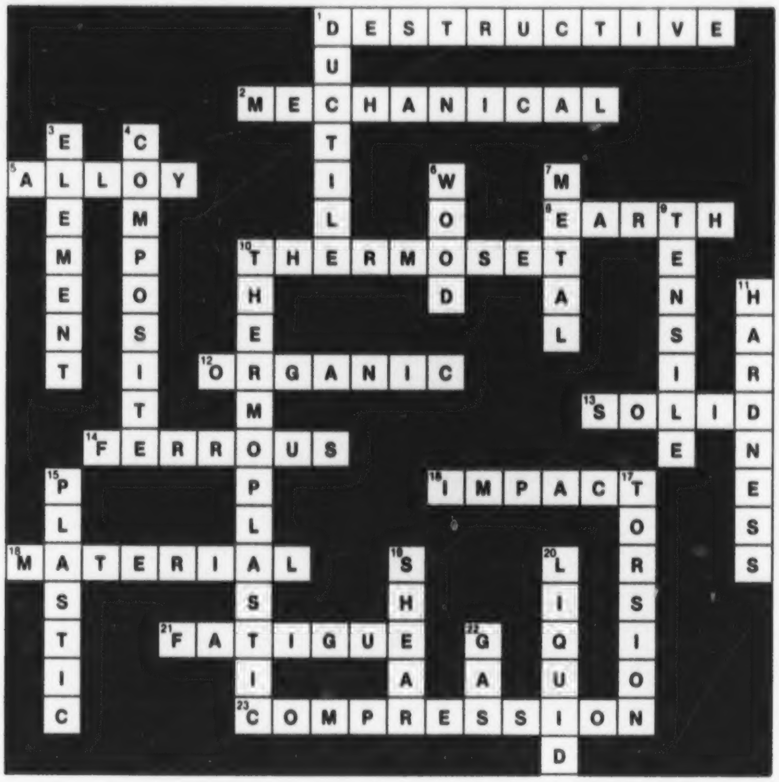
No.	Product Name	Material That Should Be Used for Manufacturing	Reason for Selection
1			
2			
3			
4			
5			

Table B

MANUFACTURING MATERIALS AND SELECTION
UNIT III

ANSWER TO ASSIGNMENT SHEETS

Assignment Sheet #1


1 DESTRUCTIVE
DUCTILE
2 MECHANICAL
3 ELEMENT
4 COMPOSITE
5 ALLOY
6 WOOD
7 METAL
8 EARTH
9 TENSILE
10 THERMOSET
THERMOPLASTIC
11 HARDNESS
12 ORGANIC
13 SOLID
14 FERROUS
15 PLASTIC
16 IMPACT
17 TORSION
18 MATERIAL
19 SHEAR
20 LIQUID
21 FATIGUE
22 GAS
23 COMPRESSION

WORD LIST:

Alloy
Compression
Composite
Destructive
Ductile
Earth
Element
Fatigue
Ferrous
Gas
Hardness
Impact
Liquid
Material
Mechanical
Metal
Organic
Plastic
Shear
Solid
Tensile
Thermoset
Thermoplastic
Torsion
Wood

Assignment Sheets #2 and #3 — Evaluated to the satisfaction of the instructor

MANUFACTURING MATERIALS AND SELECTION
UNIT III

TEST

NAME ______________________________ SCORE ______________________

1. Match the terms on the right with their correct definitions.

_____a. Materials derived from living organisms such as wood and leather

_____b. Substance which stock is made or composed of and processed into goods

_____c. Metals in which iron is the major ingredient

_____d. Plastics which are heat softened and cold hardened

_____e. Two or more elements, one of which is a metal, mixed to form a material which possesses its own characteristics

_____f. Metals containing little or no iron

_____g. Plastics that set in permanent shapes by heat and/or pressure and will not resoften

_____h. A substance that **cannot** be separated into other kinds of substances

_____i. Materials **not** derived from animals or plants

1. Alloy
2. Element
3. Ferrous
4. Gases
5. Inorganic materials
6. Liquids
7. Material
8. Nonferrous
9. Organic materials
10. Solids
11. Thermoplastics
12. Thermosets

2. Distinguish between the three states of matter by placing the following letters next to their correct descriptions:

- G — Gases
- L — Liquids
- S — Solids

_____a. Materials that retain their shape and are **not** very compressible

_____b. Fluid materials that take shape of their container and are not very compressible

_____c. Materials that have a definite melting point

_____d. Compressible materials that take the shape of their containers, and flow and diffuse easily

TEST

3. Match major types of materials used in manufacturing listed on the right with their correct definitions and descriptions.

_____a. Opaque material which is a conductor of heat and electricity; can be melted and cast; has reflective surface when polished

_____b. Natural composite material composed primarily of fibers, lignin, and other substances which make up the trunk of a tree

_____c. Materials in which two or more materials are combined together providing properties superior to those of the individual material

_____d. Materials primarily extracted from the earth's crust which are non-metallic, inorganic substances such as clay, sand, and limestone

_____e. Man-made or synthetic materials that have large heavy molecules; capable of being formed by heat and/or pressure

1. Composite materials
2. Earth materials
3. Elastomer materials
4. Ionic materials
5. Metals
6. Plastics
7. Woods

4. Match properties of materials on the right with their correct descriptions.

_____a. Properties which indicate how a material reacts to forces and loads applied to it; closely associated with strength, toughness, and durability

_____b. Ability to withstand a pulling force

_____c. Ability to withstand pushing and squeezing forces

_____d. Ability to withstand twisting forces

_____e. Ability to withstand a sudden shock; used to describe the toughness and brittleness of a material

_____f. Resistance to penetration, indentation, and abrasion

_____g. Ability to be bent, twisted, stretched or changed in shape; closely related to plasticity and malleability

1. Acoustical properties
2. Brittleness
3. Chemical properties
4. Characteristic properties
5. Compression strength
6. Ductility
7. Electrical properties
8. Fatigue strength
9. Hardness
10. Impact strength

TEST

______h. Most closely associated with properties such as shape, density, structure, or specific gravity

______i. Involves the ability to conduct heat, expansion when heated, and melting points

______j. Properties include ability to transmit, reflect, or absorb sound

______k. Includes properties of color, light reflection, light transmission, and light penetration—opaque, translucent, transparent

______l. Reactions to acidity or alkalinity and its resistance to corrosion or weathering

______m. Ability of a material to absorb repeated stress such as constant flexing or bending

11. Mechanical properties
12. Optical properties
13. Physical/Dimensional properties
14. Shear strength
15. Tensile strength
16. Thermal properties
17. Torsion strength

5. Distinguish between destructive and nondestructive testing methods of industrial materials and products by placing the following letters next to the testing methods.

- DT — Destructive Tests
- NDT — Nondestructive Tests

______a. Bend (example: free-bend)

______b. Compression

______c. Electrical (example: eddy current test)

______d. Fatigue

______e. Impact (example: Izod)

______f. Magnetic (example: "Magnaflux")

______g. Radiography (example: "X-ray")

______h. Tensile

______i. Ultrasonic

______j. Visual

TEST

6. Select from the following list the four major factors for material selection by placing an "X" in the appropriate blanks.

_____a. Availability

_____b. Color

_____c. Properties

_____d. Environmental effects

_____e. Quantity

_____f. Economics (cost)

7. Distinguish between the types of woods and their characteristics by placing the following letters next to their correct descriptions or examples.

- H — Hardwoods
- S — Softwoods

_____a. Have large vessels (large, hollow, tube-like cells which conduct nutrients)

_____b. Come from trees with needlelike or scalelike leaves; most are conifers and evergreens

_____c. Are classified as "non-porous"

_____d. Come from trees which are broadleaf and are deciduous

_____e. Examples are pine, fir, spruce, redwood

_____f. Classified as open-grained or close-grained

_____g. Examples are oak, maple, walnut, cherry

_____h. Typically have resin ducts as part of their structure

8. Select from a list the three major ways to identify various woods by placing an "X" in the appropriate blanks.

_____a. Microscopic examination

_____b. Burn tests

_____c. Examination of color, weight, porosity, and grain

_____d. Mechanical tests

_____e. Number system

TEST

9. Select true statements concerning the properties and characteristics of wood by placing a "T" next to the true statements and an "F" next to the false statements.

_____a. Wood is relatively lightweight when compared to other major industrial materials.

_____b. Wood shrinks as it takes on moisture and swells as it loses moisture.

_____c. Wood is a good conductor of heat and electricity.

_____d. Moisture affects the mechanical and non-mechanical properties of wood.

_____e. Some woods are likely to decay in contact with moisture, while other woods exhibit resistance to decay.

10. Select from the following list the correct advantages of wood by placing an "X" in the appropriate blanks.

_____a. Relatively dense, and heavy in weight

_____b. High strength-to-weight ratio

_____c. Good conductor—thermal and electrical

_____d. Natural beauty—some do not require finish or coating

_____e. Good performance vs fire—does not buckle or melt like steel or plastics

_____f. Some species are decay and chemical resistant

_____g. Inorganic

_____h. Easy to work by hand and power tools

11. Complete the following statements concerning the forms of wood materials and how they are sold by placing the number(s) corresponding to the best answer(s) in the appropriate blank.

_____a. Solid lumber is specified according to ____________, ____________, and ____________.
    1) height, width, and weight
    2) depth, height, and length
    3) cups, ounces, and pounds
    4) thickness, width, and length

_____b. Solid lumber (except molding) is sold by the ____________.
    1) linear foot
    2) board foot
    3) square foot
    4) foot

TEST

_____c. Modified/engineered wood materials are sold by the ____________ .
1) linear foot
2) board foot
3) square foot
4) foot

_____d. Examples of modified/engineered wood materials include ____________ ,
____________ , and ____________ . (Indicate three answers)
_____e. 1) plywood
2) fiberboard
_____f. 3) expandoboard
4) particle board

12. Distinguish between the types of metals and their characteristics by placing the following letters next to their correct descriptions or examples.

- F — Ferrous metals
- N — Nonferrous metals
- R — Refractory metals

_____a. Contain no iron except in very small quantities as impurities

_____b. Examples include iron and steel alloys

_____c. Examples include tungsten, tantalum, titanium, and columbium

_____d. Examples include aluminum, magnesium, zinc, and lead

_____e. Any metal with a melting point over 3000° F.

13. Select true statements concerning metals identification and designation by placing a "T" next to the true statements and an "F" next to the false statements.

_____a. Metals may look very similar, but be very different.

_____b. "Spark testing" is used for identifying nonferrous metals.

_____c. "Number systems" have been developed to identify the basic composition of casting alloys and wrought (formed) metals.

_____d. As metals are subjected to heat, their appearance *may* change, which is the basis of "flame tests".

_____e. The "solvent test" is commonly used to determine the chemical content of metals.

TEST

14. Select from the following list the correct properties of metals by placing an "X" in the appropriate blanks.

_____a. Transparent

_____b. Thermal insulator

_____c. Reflective when polished

_____d. Expands when cooled

_____e. Opaque

_____f. Conductor of electricity

15. Complete statements concerning the forms of metal materials and how they are sold by placing the number corresponding to the best answer(s) in the appropriate blanks.

_____a. The form of metal used for casting is called a(n) ____________ .
1) Ingot
2) Slab
3) Bloom
4) Billet
5) Bar

_____b. The primary forms of wrought alloys are ____________ , ____________ , and ____________ . (Mark three answers)
_____c. 1) Ingots
2) Slabs
_____d. 3) Blooms
4) Billets
5) Bars

_____e. Rods, tubing, angles, I-beams, and channels are examples of ____________ shapes.
1) Plate
2) Slab
3) Profile
4) Form
5) Shadow

_____f. Secondary forms of wrought metals are typically sold by ____________ , ____________ , and ____________ . (Mark three answers)
_____g. 1) Foot
2) Weight (pounds)
_____h. 3) Cubic foot
4) Board foot
5) Piece

TEST

16. Distinguish between the types of plastics by placing the following letters next to their correct description, examples, or analogy.

- TS — Thermosets
- TP — Thermoplastics

______a. Heat softened, cold hardened; can be reheated and reshaped again and again

______b. Examples: Epoxy, phenolic resins

______c. Analogy: Like candle wax or butter

______d. Examples: Polyethylene, nylon

______e. Analogy: Hard boiling an egg; baking a cake

17. Select true statements concerning nondestructive and destructive tests or checks for plastics identification by placing a "T" next to the true statements and an "F" next to the false statements.

______a. Nondestructive tests or checks of plastics identification include the softening point test and solubility tests.

______b. Testing the relationship of the weight of plastics to water is known as the solubility test.

______c. Noting the process used to produce the plastics product is one way of determining whether the plastic is a thermoplastic or a thermoset.

______d. The ignition, color of flame, characteristics of smoke, and extinguishing characteristics of plastics are observed in the burn test.

______e. Thermosets soften at lower temperatures than thermoplastics.

18. Select from the following list the correct properties of plastics by placing an "X" in the appropriate blanks. Plastics *may* exhibit which of the following properties?

______a. Transparency

______b. Low-friction

______c. Ability to be permanently colored

______d. Good conductors of heat and electricity

______e. Low melting points

______f. Flexibility

______g. Stiffness

TEST

19. Match the forms of plastics materials on the right with their correct descriptions.

_____a. Powders, pellets, and preformed shapes

_____b. Less than 0.010 inch thick "sheets"

_____c. Glues, cements, and caulks

_____d. Slender shafts of plastics; fishing line, fabrics

_____e. Paint, plastisol dispersion

_____f. Rods, tubes, bars, and pipe

1. Adhesives
2. Casting compounds
3. Coatings
4. Dimensional and profile shapes
5. Filaments and fibers
6. Films
7. Foams and cellular forms
8. Molding compounds

20. Match the types of earth materials on the right with their correct definitions, descriptions, or example.

_____a. Composed largely of silica ranging from opaque to optically clear; hard, relatively non-porous

_____b. Finely ground, dehydrated gypsum rock

_____c. Small weathered rock fragments, or rock shaped for building

_____d. Adhesive paste which coats surface of sand and gravel

_____e. Combination of ceramics and metals

_____f. Solid portion of the earth's crust

_____g. One-piece mass formed from combining cement with aggregate and water

1. Cement
2. Ceramics
3. Cermets
4. Clay
5. Concrete
6. Glass
7. Plaster
8. Rock
9. Stone

TEST

21. Complete the following statements concerning major parts of composites by placing the number corresponding to the best answer in the appropriate blank.

_____a. The part of a composite which provides the bulk for the material in the form of layers and fibers is called ____________ .
1) Matrix
2) Paste
3) Laminate
4) Compost
5) Filler

_____b. The bonding agent for holding the bulk of the composite material together is called ____________ .
1) Matrix
2) Paste
3) Laminate
4) Compost
5) Filler

22. Select true statements concerning the history of composites by placing a "T" next to the true statements and an "F" next to false statements.

_____a. Ancient builders added straw to clay to increase strength of bricks.

_____b. Composite materials were first used and developed in the twentieth century.

_____c. Composite materials benefit society in the form of laminated beams, graphite tennis rackets, and radial tires.

23. Distinguish between the types of composite structures by placing the following letters next to the appropriate descriptions and examples.

- LC — Layered (laminate) composites
- FC — Fiber (fibrous) composites
- PC — Particle (particulate) composites

_____a. Examples include cermets, concrete, and flakeboard

_____b. Examples include glass-reinforced plastic, steel radial tires, and Masonite®

_____c. Examples include "honeycomb" panels, plywood, and cardboard boxes

_____d. Fibers form the binding force and carry the load in reinforcing a material

TEST

24. Select from the following list the correct advantages of composites by placing an "X" in the appropriate blanks.

_____a. Improved properties

_____b. Decreased overall cost

_____c. Low resistance to chemicals

_____d. Increased thermal expansion

_____e. Improved design flexibility

_____f. Increased water absorption

_____g. Increased toughness

_____h. Decreased stability

25. Complete statements concerning other manufacturing materials in common use by placing the number(s) corresponding to the best answer(s) in the appropriate blank.

_____a. An organic material characterized by its high coefficient of friction, flexibility, and elastomeric properties, describes ____________ .
1) Leather
2) Rubber
3) Textiles
4) Corform
5) Paper

_____b. Materials such as water, wood pulp, rags, and pigment are used in the manufacture of ____________ .
1) Leather
2) Rubber
3) Textiles
4) Corform
5) Paper

_____c. The tough, organic material made from the skins of animals is known as ____________ .
1) Leather
2) Rubber
3) Textiles
4) Corform
5) Paper

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

26. Complete crossword puzzle of manufacturing materials terminology. (Assignment Sheet #1)

27. Test materials and products. (Assignment Sheet #2)

28. Select and identify materials used for manufacturing products. (Assignment Sheet #3)

MANUFACTURING MATERIALS AND SELECTION
UNIT III

ANSWERS TO TEST

1. a. 9
b. 7
c. 3
d. 11
e. 1
f. 8
g. 12
h. 2
i. 5

2. a. S
b. L
c. S
d. G

3. a. 5
b. 7
c. 1
d. 2
e. 6

4. a. 11
b. 15
c. 5
d. 17
e. 10
f. 9
g. 6
h. 13
i. 16
j. 1
k. 12
l. 3
m. 8

5. a. DT
b. DT
c. NDT
d. DT
e. DT
f. NDT
g. NDT
h. DT
i. NDT
j. NDT

6. a, c, d, f

7. a. H
b. S
c. S
d. H
e. S
f. H
g. H
h. S

8. a, c, d

ANSWERS TO TEST

9. a. T
b. F
c. F
d. T
e. T

10. b, d, e, f, h

11. a. 4
b. 2
c. 3
d. 1
e. 2 Any order
f. 4

12. a. N
b. F
c. R
d. N
e. R

13. a. T
b. F
c. T
d. T
e. F

14. c, e, f

15. a. 1
b. 2
c. 3 Any order
d. 4
e. 3
f. 1
g. 2 Any order
h. 5

16. a. TP
b. TS
c. TP
d. TP
e. TS

ANSWERS TO TEST

17. a. F
    b. F
    c. T
    d. T
    e. F

18. a, b, c, e, f, g

19. a. 8
    b. 6
    c. 1
    d. 5
    e. 3
    f. 4

20. a. 6
    b. 7
    c. 9
    d. 1
    e. 3
    f. 8
    g. 5

21. a. 5
    b. 1

22. a. T
    b. F
    c. T

23. a. PC
    b. FC
    c. LC
    d. FC

24. a, b, e, g

25. a. 2
    b. 5
    c. 1

26.-28. Evaluated to the satisfaction of the instructor

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the major manufacturing processes and select appropriate processes for producing a manufactured product. Competencies will be demonstrated by completing the assignment sheets, job sheets, and the unit tests with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to manufacturing processes and selection with the correct definitions.
2. Arrange in order the stages in material processing.
3. Complete statements concerning the three major processes for acquiring raw materials.
4. Complete statements concerning the primary processes for producing industrial materials.
5. Match secondary processes with the correct definitions.
6. Complete statements concerning the three elements of separating.
7. Match separating processes with their descriptions or examples.
8. Complete statements concerning the elements of the forming process.
9. Match forming processes with their descriptions.
10. Complete statements concerning the sequential elements of casting and molding.

OBJECTIVE SHEET

11. Match casting and molding processes with their descriptions.

12. Select from a list the considerations for determining conditioning process.

13. Select from a list reasons for conditioning materials.

14. Complete statements concerning types of conditioning processes.

15. Match typical conditioning methods for the various materials with their descriptions or examples.

16. Complete statements concerning the essential elements in assembling processes.

17. Identify types of joints.

18. Select true statements concerning the relationship between finishing and the other secondary processes.

19. Complete statements concerning the essential elements in finishing.

20. Select true statements concerning the types of metallic coatings and platings.

21. Select true statements concerning general safety rules for manufacturing.

22. Complete a crossword puzzle of "manufacturing processes" terminology. (Assignment Sheet #1)

23. Identify products which have been formed. (Assignment Sheet #2)

24. Identify products which have been cast or molded. (Assignment Sheet #3)

25. Survey the school laboratory for secondary processes and associate them with the major industrial material. (Assignment Sheet #4)

26. Complete a separating process analysis chart. (Assignment Sheet #5)

27. Complete a forming process analysis chart. (Assignment Sheet #6)

28. Complete a casting and molding process analysis chart. (Assignment Sheet #7)

29. Complete a conditioning process analysis chart. (Assignment Sheet #8)

30. Complete an assembling process analysis chart. (Assignment Sheet #9)

31. Complete a finishing process analysis chart. (Assignment Sheet #10)

OBJECTIVE SHEET

32. Demonstrate the ability to:

    a. Cut steel and drop forge a screwdriver blade. (Job Sheet #1)

    b. Layout, grind screwdriver blade to shape, and bend. (Job Sheet #2)

    c. Perform heat treatment, hardness testing, and bead blasting of screwdriver blade. (Job Sheet #3)

    d. Test screwdriver blade using liquid penetrant testing. (Job Sheet #4)

    e. Finish screwdriver blade using "electroless electroplate". (Job Sheet #5)

    f. Make a WEP handle for screwdriver. (Job Sheet #6)

    g. Trim the handle and finish the screwdriver. (Job Sheet #7)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

(NOTE: Additional transparency masters dealing with manufacturing are included in MAVCC's *Exploring Technology Education*, Section D.)

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

(NOTE: You may also wish to provide your students with the word list that corresponds to the crossword puzzle on Assignment Sheet #1. This list is included with the answers to that assignment sheet.)

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed. Assignment Sheets #5-#10 are divided into Parts A and B. You may wish to assign only Part A or both Parts A and B depending on the level of your students and time allowed.)

G. Provide students with job sheets.

H. Discuss and demonstrate the procedures outlined in the job sheets.

I. Integrate the following activities throughout the teaching of this unit:

1. Have the students identify the materials and processes which will be used during the manufacturing enterprise.

2. Provide instruction for each process. (Include safety considerations).

3. Have the enterprise management assign production jobs and prepare jigs and fixtures.

4. Other activities or products may be substituted for the job sheets such as those developed by

   The Parke System
   805 S. Devonshire
   Springfield, MO 65802

5. Substitute Birchwood-Casey's gun blueing solution to finish the screwdriver blade in Job Sheet #5.

6. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

SUGGESTED ACTIVITIES

J. Give test.

K. Evaluate test.

L. Reteach if necessary.

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MANUFACTURING PROCESSES AND SYSTEMS
UNIT IV

INFORMATION SHEET

I. **Terms and definitions** (Assignment Sheet #1)

A. Natural resources — Those forms of wealth (materials and energy) supplied by nature

Examples: Minerals, timber, land, water, plants, animals

B. Ore — Natural combination of minerals from which metals can be extracted

Example: Bauxite (aluminum ore)

C. Recycle — Reprocessing of waste materials into useful products; reuse of all or part of a material

Example: Recycling old newspapers to produce paper products

D. Raw material — Material which can be converted by manufacturing or processing into a new and useful product

Examples: Timber is a raw material for a lumber mill, and wheat is a raw material for a flour mill

E. Ingots — Metal cast into a form that can be remelted or reshaped to form another metal product

Example: Aluminum ingot for casting products

F. Refining — Process of removing impurities from materials

Example: Refining of crude oil into petroleum products

II. **Stages in material processing**

A. **Acquire raw materials** — Locate, gather, and collect raw materials from the natural resources

Example: Mine bauxite (aluminum ore)

B. **Produce industrial materials** — Convert raw materials into industrial materials (standard stock) through "primary processes".

Example: Refine aluminum into aluminum ingots or primary shapes

INFORMATION SHEET

C. **Produce finished goods** — Change industrial materials into finished products through "secondary processing".

Example: Use impact extrusion to produce aluminum cans for beverages.

D. **Recycle or dispose of unwanted materials** — Materials in the form of scrap, waste, or undesirable products must be disposed of or recycled. It is important to conserve natural resources and protect the environment.

Example: Recycle aluminum cans

III. **Processes for acquiring raw materials**

A. Harvesting — The gathering of mature, renewable, raw materials from the earth.

Examples: Cutting wood (lumbering); picking cotton

B. Drilling — Narrow, round shafts are put into the earth through which materials (liquid or gas form) are pumped to the earth's surface.

Example: Drilling for oil or natural gas

C. Mining — The digging of holes or a series of tunnels to acquire raw materials

Example: Mining iron ore

(NOTE: Drilling and mining are associated with "extracting" materials from within the earth.)

IV. **Primary processes for producing industrial materials** — Operations by which natural resources are converted to products that manufacturing plants can use

A. Thermal (heat) processes

Examples: Smelting lead, zinc, copper (metal is separated from ore by melting), steel making

B. Mechanical processes

Examples: Rock crushing gypsum for plaster, manufacturing lumber, particle board, and plywood

C. Chemical processes

Examples: Forming polymers (plastics) by combining chemical elements, refining aluminum, tanning leather, making paper

(NOTE: Sometimes more than one primary process is used to produce industrial materials.)

INFORMATION SHEET

V. **Secondary processes** — Operations that use the industrial materials produced by primary production processes to make finished products. (Assignment Sheets #2-#4)

A. Separating — Removing excess material to produce a desired size, shape, or finish

B. Forming — Changing the size and shape of a material, but not the volume

C. Casting and molding — Pouring or forcing a material in liquid form into a mold and allowing it to harden before removal. Casting uses only gravity to fill the mold as material is poured. Molding requires additional force.

D. Conditioning — Changing the internal structure of industrial materials to give them desired properties so they can be better used

Examples: Baking dough to make bread, firing ceramic clay to make vases

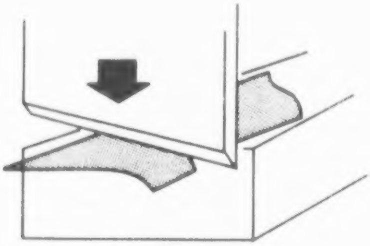
E. Assembling — Bringing parts together so that they stay together for a definite period of time

F. Finishing — Protecting or decorating a finished product

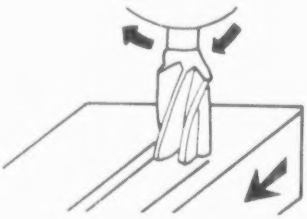
(NOTE: A post production process that is necessary for the continual use of many produced goods is servicing which includes all activities necessary to keep a product functioning properly or to get it to resume functioning after it has failed.)

VI. **Elements of separating** (Assignment Sheet #5)

A. **Tool or cutting element** — This element as seen in traditional separating processes—drilling, turning, shearing, etc.—is in the form of *single-point tools* and *multiple-point tools*. Non-traditional separating methods—electrical discharge machining (EDM), chemical milling, laser beam machines, etc.—do not use "tool cutters" but use electrical arcs, chemical action, and heat (flame) to separate material.



Single-point tool



Multiple-point tool

INFORMATION SHEET

B. **Movement between the cutting element and the material being cut (workpiece)** — The tool and/or the workpiece will have rotary (turning), reciprocating (back and forth, up and down), or linear (straight-line) motion associated with it. This element includes two types of motion:

1. Cutting motion — Motion between the tool and the work
2. Feed motion — Movement that brings the tool in contact with new material to be separated

C. **Support or clamping** — Method used to hold tool or workpiece in one position. Vises, clamps, hold downs, and other devices are used to secure either the workpiece or the tool to ensure more accurate cuts. The type of holding device used is dependent on the types of motion used in the separating process.

(NOTE: These three elements—tool or cutting element, movement, and clamping devices—will always be present in some form or fashion. However, they may be different for a given process and vary from material to material. For example, in sawing, a circular saw rotates while a scroll saw reciprocates. Portable and hand saws move through the work while the work moves through the blade in sawing machines.)

VII. **Separating processes** (Transparencies 1 and 2 and Assignment Sheet #5)

A. **Sawing** — Cutting with a tool having pointed teeth equally spaced *along the edge* of a blade.

Hand tool example: Hack sawing metal

Machine tool example: Circular sawing wood

B. **Shearing** — Cutting, usually between two cutting edges crossing one another, or by forcing a single cutting edge through a workpiece.

Hand tool example: Scissors cutting paper; paper punch

Machine tool example: Metal cutting shear or metal punching machine

C. **Turning** — Cutting by revolving a workpiece against a fixed single-edge tool.

Example: Lathe

D. **Abrading** — Cutting by wearing away material, usually by the action of mineral particles.

Hand tool example: Hand sanding

Machine tool example: Grinder, high-pressure water jet machining, sand blasting

INFORMATION SHEET

E. **Milling** — Cutting with a tool having sharpened *teeth equally spaced* around a *cylinder* or along a *flat surface*.

Hand tool example: Filing

Machine tool examples: Milling machine (metals), planer or surfacer (wood), jointer (wood), shaper (wood)

(NOTE: As can be seen in the above example, just because a machine is called a shaper (wood), does not mean it separates material according to the *shaping process*. The key is understanding the process.)

F. **Shaping** — Cutting by moving a *single-edge* tool across a fixed workpiece in a *straight-line* cutting path.

Hand tool example: Planing wood by hand with a block plane

Machine tool example: Metal shaper

G. **Drilling** — Cutting with a cylindrical tool using two rotating cutting edges to form or enlarge a hole.

Example: Using a drill press to drill holes

H. **Electrical, electro-chemical, chemical, thermal erosion** — Cutting by non-traditional techniques using ideas that are old, but some of the machines and their uses are very new. All involve separating by heat or acids.

Examples: Electrical discharge machining (EDM), laser beam machining, flame cutting (oxyacetylene), chemical milling

I. **Induced-fracture** — A tool is used to score (shallow cut or scratch) a line along an axis so stock breaks easily.

Example: Cutting glass

VIII. **Elements of the forming process** (Assignment Sheet #6)

A. **Forming devices** — Dies and rolls that determine the final shape of the product.

1. **Dies** — These are hardened pieces of material which are used to shape softer materials. Dies are:

a. Open — Simplest die; two flat mold parts, one part moving and the other stationary

Example: Hammer (moving) and anvil (stationary)

INFORMATION SHEET

b. Mated or closed — Die halves are machined to form desired shape when material is forced into them

Example: Die for drop forging screwdriver

c. One-piece shaped — A die which materials are formed around or forced into or through by many different processes.

Examples: Metal spinning chuck (die), drawing die, extrusion die

2. **Rolls** — Series of rolls which materials move through to process them to a particular shape. Rolls may be *smooth* or *shaped*.

Example: Smooth rolls to form flat sheets of material

B. **Forming temperature of material** — Correct degree of heat or cold to form the material without causing internal stress

1. **Hot-formed** — Material is heated above the temperature at which it can be shaped without causing internal stress. This allows the material to be formed using lower forming pressures and the hardness of the material will not be changed.

Example: Hot-rolled steel (HRS)

2. **Cold-formed** — Forming is done below the lowest temperature material may be shaped without causing internal stress. The material may be formed at room temperature or heated. Cold-formed products have smoother finishes, improved strength, tighter grain structure, greater hardness, and improved dimensional accuracy.

Example: Cold-rolled steel (CRS)

3. **Other** — Materials such as clay are in a plastic state (hot liquid) and are formed at room temperature. Also materials such as wood are softened by steam to allow them to be formed.

(NOTE: The softer [usually hotter] the materials, the less pressure required to reshape them.)

C. **Source of forming pressure** — Using machines or other forming system to the desired shape.

1. Forming machine tools

a. Rolling machines

Examples: Rolling sheet steel

INFORMATION SHEET

b. Presses

Example: Press for press forging operations (metals)

c. Hammers

Example: Hammer for drop forging (metals)

d. Draw bench

Examples: Forming wire; stretch forming (metal)

e. Bending machine

Examples: Bar folder for bending sheetmetal

2. Other forming systems

a. Hand and hand tools

Example: Forming clay with the hands

b. Air pressure

Example: Pressure forming plastic

c. Vacuum pressure

Example: Vacuum forming plastic

d. High energy rate forming (HERF)

Example: Explosive forming and electromagnetic forming metals

IX. **Forming processes** (Transparencies 3 and 4 and Assignment Sheet #6)

A. Bending — Process of straining material uniformly around a die or straight axis

Example: Bending sheet metal with a bar folder

B. Extrusion — Process of forcing metal from a closed chamber through a die opening which controls its cross-sectional shape

Example: Extrusion of plastic pipe; squeezing toothpaste from its container

INFORMATION SHEET

C. Pressing — Process of squeezing sheet material between two dies to form desired shape

Example: Embossing metal license plates

D. Rolling — Process of squeezing a workpiece between rotating rollers to generally produce sheets or plates; material decreases in thickness and typically increases in length

Example: Rolling sheet metal; calendering paper and plastics; rolling out pie dough

E. Drawing — Process of pulling metals through a series of dies which progressively reduces the metal in cross-sectional area and increases its length

Example: Drawing copper wire

F. Forging — Process of using compressive force or applying blows to a workpiece to form it into a desired shape

Example: Drop forging a screwdriver blade

G. Blow molding — Process of forming a molten hollow tube (parison) of plastic or glass, which is trapped in a mold, where air pressure is introduced to force the plastic or glass to the internal shape of the mold

Example: Blow molding plastic milk bottles

H. Thermoforming — Process of using force (air pressure, vacuum, mechanical force) to form heated plastic sheets to the contour of a mold

Example: Vacuum forming signs

I. High Energy Rate Forming (HERF) — Process of using detonated explosives, electromagnets, or other high energy rate force to produce parts of desired shape in a die

Example: Explosive forming metal parts

(NOTE: There are many other forming processes that are specific to materials such as coining metals, hydroforming metals, forming laminates, stretch forming metals, and many others.)

INFORMATION SHEET

X. **Sequential elements of casting and molding** (Assignment Sheet #7)

A. The mold — A mold of the proper shape is produced. These may be one-shot molds or permanent molds for repeated use. Molds may be open one-piece molds or complex multiple-piece molds.

1. One-shot molds — These molds are good for one-time use and are expendable. These are typically composed of sand and binders or plaster.

   Example: Pouring aluminum into a green sand mold or shell mold

2. Permanent-type mold — molds can be used over and over again and still produce quality castings and products. These molds are typically made out of materials which melt at temperatures significantly higher than material poured into them, and are capable of withstanding the effects of heat and molding pressure. They must also *not* react to the material entering them. Examples of molds include:

Process	Material Cast or Molded	Mold Material	No. of Mold Pieces
Wood flour molding	Wood flour and melamine resin	Steel	2
Slip casting	Slip (liquid clay)	Plaster	1 or more
Permanent molding	Low temperature metal (lead)	Aluminum	1 or more
Permanent molding	Aluminum	Gray iron	2 or more
Casting (plastic)	Polyester resin	Polyethylene	1 or more
Casting (plastic)	Plastisol	Silicone	1 or more
Injection molding	Polyethylene	Steel	2 or more

3. Coring — To form hollow passages or openings in casting and molded products, cores are used. Material flows around these objects (cores) which are removed from the part once solidification is complete.

INFORMATION SHEET

B. Casting or molding material preparation — The material is prepared for casting. Material must be liquid or semiliquid. The material must be:

1. Dissolved — Material is made liquid by the addition of solvents (including water).

   Example: Plastisol resins (plastics) used in dip casting to make a coin purse. Slip is clay made liquid by the addition of water.

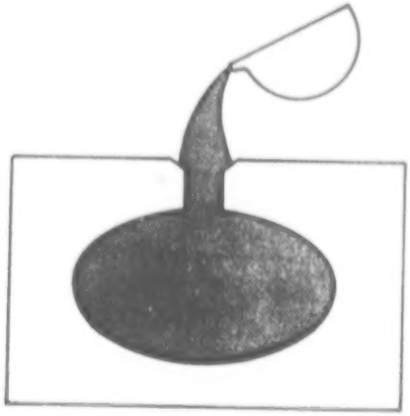
2. Melted — Heated till material becomes liquid.

   Example: Lead (metal) is melted and poured into a permanent mold to make "sinkers".

3. Compounded — Additives are mixed together in a compound which becomes liquid and is then cast.

   Example: Colorants (coloring materials) and catalyst are compounded with polyester resin, which is then poured into a rubber mold to produce a chess piece.

C. Introduction of material into the mold — Material is poured or forced under pressure into the mold. When material is poured into the mold and filled by gravity flow, it is called a **casting**. When additional forces or pressure is used, the process is called **molding**.



Examples: Gravity poured—Sand mold, slip casting mold (casting)
Forced—Die casting metals, injection molding plastics (molding)

INFORMATION SHEET

D. Solidification of material in the mold — Material is allowed or forced to harden (solidify). Solidification occurs by either drying, chemical action, or cooling.

1. Drying or solvent removal

Example: Liquid slip is poured into a plaster mold. The plaster mold absorbs the water from the slip causing the casting's outer surface to become dryer. The remaining liquid slip is poured out of the mold creating a hollow casting that is allowed to dry.

Some plastic films are made by suspending plastics in a solvent, which is then poured out on a very smooth surface. The solvent evaporates off leaving a thin layer of film.

2. Chemical action

Examples: Casting plaster or plastic resins such as water-extended polyester (WEP)

(NOTE: When chemical action takes place, heat will be given off.)

3. Hardening

Example: When metals cool well below their melting temperature, they solidify or become hard. Thermoplastics (heat softened, cold hardened) behave the same way.

E. Product (casting) removal from mold — The solidified part is removed from the mold by one of two ways.

1. Opening the mold — Permanent-type molds are opened and can be used over and over again.

Example: Permanent mold for metals
Slip cast mold for ceramics

2. Destroying the mold — A one-shot mold is destroyed so the part (casting) can be removed.

Example: Sand cast mold
Mold used to cast lost wax metal products

XI. **Casting and molding process** (Assignment Sheet #7)

A. Casting processes (Transparency 5)

1. Casting solid objects

a. Sand casting — Process in which molten material is poured into a mold made of aggregate material. Mold is destroyed to remove part.

Examples: Green sand casting; shell molding

INFORMATION SHEET

b. Investment casting — Patterns commonly made of wax or low-temperature plastics are left inside mold and later vaporized out to allow metal to occupy space of pattern.

Examples: Lost wax process for jewelry making, dental work, precision castings; lost foam process for engine parts

c. Permanent molding — Metals or other materials are poured into a mold (gravity pressure fills it) and the casting is later removed without destroying the mold.

Examples: Permanent molding of lead sinkers or soldiers
Casting concrete planters in aluminum or steel molds

d. Dip casting — Casting in which heated mold is dipped into plastic and part is formed on the outside of mold.

Examples: Dip casting of coin purses; surgical gloves

2. Casting hollow objects — Excess material is poured out

a. Slush casting (metals, plastics)

b. Slip casting (clay)

3. Casting using rotation or centrifugal forces

a. Centrifugal casting (metals) — Material is forced against mold wall or into mold cavities

Examples: Making pipe; spin casting belt buckles

b. Rotational casting (plastics) — Molten material coats inside surface of mold as it rotates on two axes

B. Molding processes (Transparency 6)

1. Compression-type molding

a. Wood flour molding (wood)

b. Powder metallurgy (sintering) (metals)

c. Hot press-sintering (plastics)

d. Transfer molding (plastics)

e. Compression molding (plastics)

INFORMATION SHEET

2. Injection-type molding — Material forced (injected) into mold cavity
   a. Die casting (metals)
   b. Injection molding (plastics)

XII. **Considerations for determining conditioning process**

A. Establish the mechanical property requirements of materials

B. Determine what internal structure is needed to obtain desired properties

C. Select steps needed to accomplish the internal change

XIII. **Reasons for conditioning materials**

A. To make material easier to form or separate

Example: Aluminum can be heat treated by annealing (to soften) to make it easier to cut or use in metal spinning.

B. To remove internal stress built up during the manufacturing process

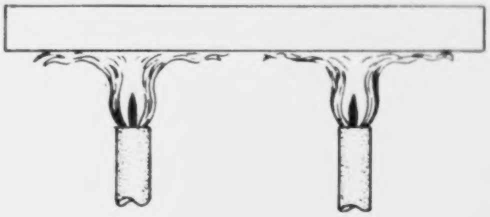
Example: Welded metal parts are heat treated by normalizing (heated and cooled slowly to remove stresses) to keep them from cracking or distorting because of internal stress.

C. To impart certain properties (hardness, ductility, toughness, strength, or stiffness)

Example: To make a very ductile copper material stiff and hard, it can be "peened"—hit all over with the peen end of a ball-peen hammer.

XIV. **Types of conditioning processes** (Assignment Sheet #8)

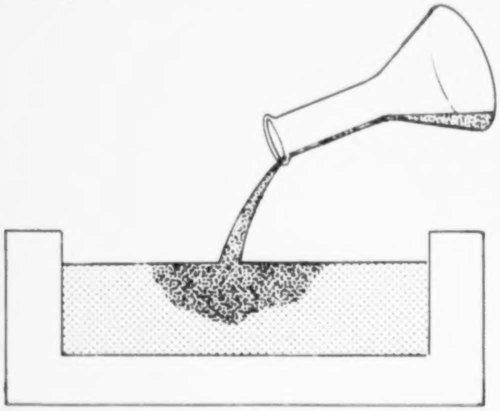
A. Thermal conditioning — Using heat to improve the physical or mechanical properties of a material



Examples: Drying (seasoning) wood, heat-treating metal (hardening, tempering, annealing), firing ceramics

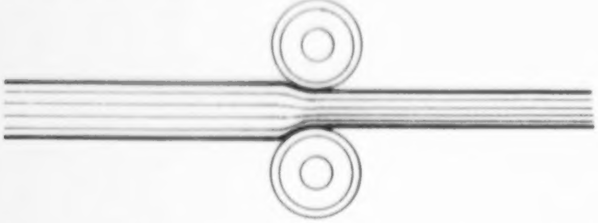
INFORMATION SHEET

B. Chemical conditioning — Adding a chemical to improve the physical or mechanical properties of a material



Examples: Adding yeast to bread dough to make it softer, adding manganese to molten steel to make it stronger

C. Mechanical conditioning — Using pounding or squeezing action to change the internal structure and thereby improve the physical or mechanical properties of a material



Examples: Pounding steak to break the tough connecting fibers and make it more tender, compressing wood to make it take up less space and still be strong

XV. Typical conditioning methods by material

A. Wood

1. Drying (seasoning) — Using air-drying techniques or kilns to dry wood to improve the dimensional stability of wood. It improves mechanical properties and ability to be processed—machining and finishing.

2. Steaming — Using steam to soften wood so it can be bent and shaped without breaking

INFORMATION SHEET

B. Metals

1. Hardening — Make material hard. Can be hardened through thermal, mechanical (peening), or chemical (nitriding for case hardening) processes.

2. Annealing — Soften material for forming or cutting; for example, soften material to be explosive formed. Typically annealed by thermal conditioning.

3. Tempering — Reheating hardened or normalized materials to a specific temperature and holding it at that temperature for a specified time to produce desired properties.

   Example: Tempering a hardened screwdriver blade

4. Normalizing — Heating ferrous materials to a suitable temperature range and then cooling in air to a temperature below the range in which the structure of the metal changes. Parts are normalized to reduce stresses. Closely related to annealing.

   Example: Removing stresses in machined parts

5. Case hardening — Only the surface layer of iron-based alloys are hardened, leaving the inner core of the material softer. Conditioning can be thermal and/or chemical.

   Example: Case hardening of mild steel (lacks carbon content to be hardened)

6. Alloying — Different alloying elements are added to ferrous and nonferrous materials to impart desirable casting, machining, and forming characteristics. This involves chemical conditioning.

   Example: Silicon is added to melts of aluminum to make it flow better. Lead is added to copper-base alloys to improve machining. Magnesium is added to gray iron to create ductile iron.

C. Earth materials

1. Firing — Materials are fired in a kiln to alter their chemical structure. This makes the materials very hard.

   Example: Firing greenware (clay) to form bisque (fired clay)

2. Ingredients are added to plaster and concrete to accelerate drying and/or improve properties.

   Example: Accelerators are added to speed up drying and cure times.

INFORMATION SHEET

D. Plastics — A wide variety of chemical conditioning is done to plastics. Ingredients are added to:

1. Speed up chemical action (catalyst)
2. Slow down chemical action
3. Increase shelf life (stabilizers)
4. Keep material from degrading due to ultraviolet light
5. Improve machining and molding characteristics (lubricants, plasticizers)
6. Change color

E. Composites — Many composite materials are conditioned through heat and pressure to achieve desired characteristics. For example, powdered metallurgy parts.

XVI. **Essential elements in assembling processes** (Assignment Sheet #9)

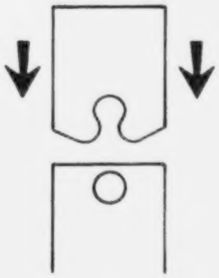
(NOTE: Materials are held together either by *mechanical fastening* or by *bonding*.)

A. Mechanical fastening — These processes use either *mechanical force* or *mechanical fasteners* to hold parts together, which many times provides for disassembly and reassembly.

1. Mechanical force — Like or dissimilar materials are held together through "snap fits", "shrink fits" and "press fitting", which are a result of being mechanically forced together.

   Example: A groove seam is used to interlock sheetmetal pieces together through mechanical force.

   Example: "Shrink fitting" involves forcing an insert into the plastic immediately after molding and allowing the plastic to cool and contract (shrink) around it.



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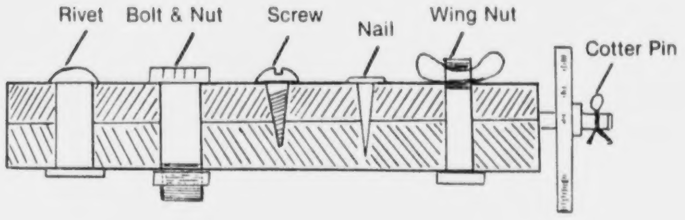
2. Mechanical fasteners — Permanent, semipermanent, or temporary fastening with devices that can hold two or more parts together. Mechanical fasteners are perhaps the most frequently used method of fastening materials. These fasteners may be classified according to how long they can hold parts together without disassembly.

   a. Permanent — Sewing, weaving, rivets

   b. Semi-permanent — Nails, screws, bolts, staples

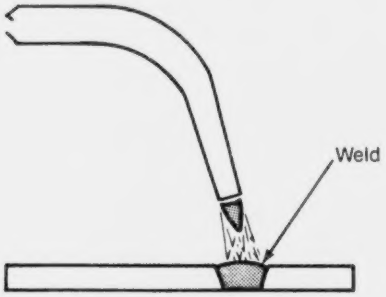
   c. Temporary — Cotter pins, clips, wing nuts, safety pins



B. Bonding — Permanent assembly method which holds parts together using pressure, heat, and/or a bonding agent. There are two major types of bonding:

1. Cohesive (fusion) bonding — Permanent fastening by fusing like materials together through localized melting or softening due to heat, pressure, or solvent. The result is the intermingling of molecules between the two parts.

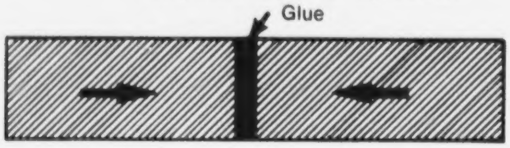
   Examples: Welding metals, using solvents to fuse like plastics together



INFORMATION SHEET

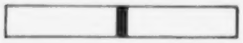
2. Adhesive bonding — Surfaces of like or unlike materials are held together by an additional material such as glue or cement.

   Examples: Wood held together by glue, plastic laminate attached to a wood cabinet by contact cement, bricks or stone held together by mortar cement, copper pipe and coupling held together by solder

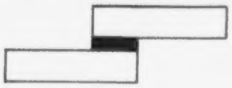


XVII. **Types of joints**

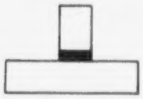
A. Butt



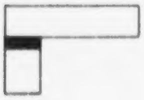
B. Lap



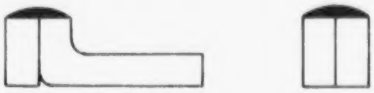
C. T



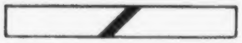
D. Corner



E. Edge



F. Scarf



(NOTE: The major manufacturing material areas will have many joints specific to their industry. For example, dovetail joints in wood.)

INFORMATION SHEET

XVIII. Relationship between finishing and other secondary processes

(NOTE: Finishing actually is a process which makes use of all the other major secondary processes in achieving its desired results. The following table shows how finishing is dependent upon the other secondary processes.)

Secondary Process	Examples of Finishing Process	Process Descriptions
Separating	Sand blast finish Wire brushing Wire wheel incising (clay) Buffing, Scraffito (clay) Abrasives, etching	Separating material by mechanical or chemical action to achieve desired finish
Forming	Knurling (metal) Peening Embossing Planishing	Displacement or moving surface material to form a new appearance
Casting and molding	As cast finish	Fineness or coarseness of casting medium determines texture
Conditioning	Bleaching (wood), ammonia, bluing Burning Peening (hardens metal)	Chemical action Thermal action Mechanical action
Assembling (combining)	Painting Electroplating Flocking Stucco Electrostatic finishing Glazing	All these processes are dependent upon the bonding of the finishing material to the surface of the material

XIX. Essential elements in finishing (Assignment Sheet #10)

A. Selection of the finishing material or method

1. Converted coatings — Converting the surface of the material into a new material usually by chemical action

   Example: Anodizing aluminum

INFORMATION SHEET

2. Coating — The addition of a second layer of material to the surface of the base material and not removing it.

   (NOTE: These coatings may be metallic [chrome plating] or nonmetallic [latex paint].)

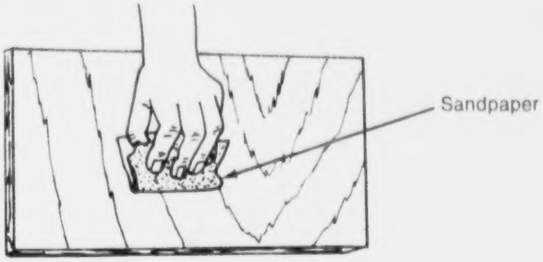
3. No finish material on surface. Surface is altered in appearance.

   Example: Sandblasting a textured finish

B. Preparation of the base material — Material is prepared by improving its smoothness and cleaning. The two principal methods are mechanical and chemical preparation.

1. Mechanical

   Example: Using abrasives ("sandpaper"), brushes, or tumbling to produce clean and smooth surfaces (very little material removed). Others include material blasting and burnishing.



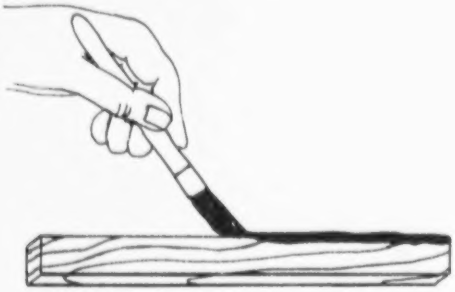
2. Chemical

   Example: Liquids or mild acids ("pickling") are used to prepare surfaces.

(NOTE: Sometimes the surface requires no mechanical or chemical preparation such as when applying an underglaze to a ceramic product.)

INFORMATION SHEET

C. Application of finish — Material is applied to the surface of material in many ways. Once applied, it either adheres to the surface (coating) or reacts with the surface (converted surface).



1. Material is applied by:

   a. Chemical — Chemicals typically react with the surface, resulting in converted surface.

      Example: Gun blueing; anodizing

   b. Electrical — Electrical current is used to deposit finishing material to surface.

      Example: Electroplate

   c. Mechanical — The principal method by which the finishing material comes in contact with the surface.

      Example: Brushing on a finish

2. Specific methods of applying finishes include:

   - Dip coating
   - Spray coating
   - Roll coating
   - Brush coating
   - Curtain coating
   - Heat transfer
   - Printing
   - Powder coating
   - Floor coating (flooded)
   - Electrocoating

   (NOTE: Chemical and electrical methods of application are most closely associated with converted surfaces. However, all three of the application methods are often combined to achieve desired finishes.)

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XX. **Metallic coatings and platings**

A. Conversion coatings

1. Anodized coatings

2. Oxide coatings

3. Other—includes phosphate and chromate coatings

B. Coating finishes

1. Metallizing — Wire metallizing or flame spraying, plasma-arc spraying or vacuum metalizing

2. Electroless and immersion-type — Deposit coating of zinc, copper, tin, gold, nickel, cobalt

3. Electroplating — Deposit coating including silver, gold, chrome, zinc, copper, tin, cadmium

4. Diffusion coatings — "Surface hardening"

5. Dipping — Hot dipping zinc (galvanize) is most common

C. Materials used for plating

1. Zinc — Galvanized steel, used to prevent oxidation (rust formation)

2. Lead — Terne plate, used for acid tanks

3. Tin — Tin plate, food container application

XXI. **General safety rules for manufacturing**

(NOTE: Since power equipment will be used in this phase of your class, it is important that you follow each of the following rules.)

A. Obtain instructor's approval before operating any power equipment.

B. Always wear proper eye protection devices when working in the laboratory, whether or not you are operating a machine.

C. Remove jewelry and confine loose clothing and long hair.

D. Never operate a machine if over-tired or ill.

INFORMATION SHEET

E. Think operations through before performing them.

F. Make all the necessary adjustments before turning on the power.

G. Make sure all guards are in place and functioning properly.

H. Allow the machine to reach its full operating speed before starting to feed the work.

I. Use only the approved push sticks, push blocks, and feather-boards.

J. Keep machine tables and working surfaces clear of tools, stock, and other materials.

K. Feed the stock carefully and only as fast as the machine will accept it easily.

L. Keep hands a minimum distance of 4" away from the cutting tool.

M. If a machine is not working properly, inform the instructor immediately.

N. Do not allow your attention to be distracted while using a machine.

O. Avoid "walking through" or "crowding around" areas where machines are being operated by others.

P. Never leave machines running while unattended.

Q. Do not use machines for trivial operations.

R. Use a small brush to clean machines after operations are completed.

S. When oiling or adjusting a machine, be sure the power switch is "off".

T. If an object is too heavy or awkward to lift or carry, get help.

U. Place oily rags used to wipe down machines in an approved, covered metal container.

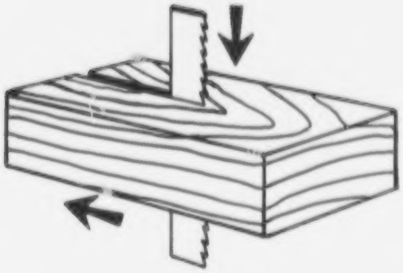
V. Check portable and stationary power tools for frayed electrical cords.

W. Inspect drill bits and cutters before using.

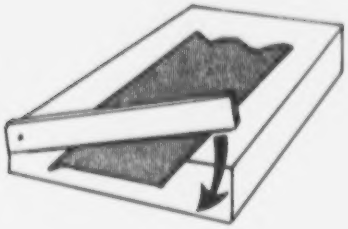
X. Report dull cutting tools to the instructor.

Y. Use a machine only after receiving proper instruction and permission from the instructor.

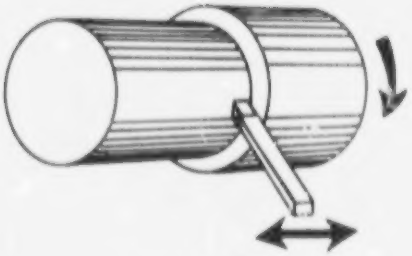
Separating



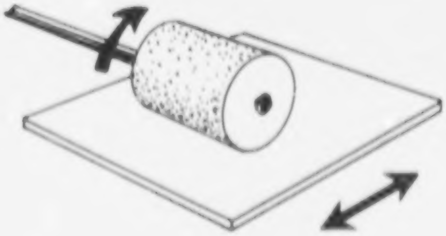
Sawing



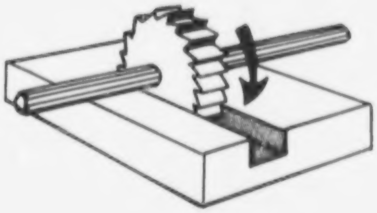
Shearing



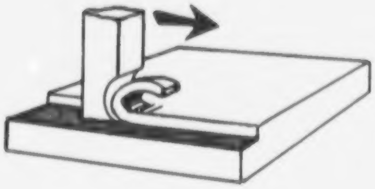
Turning



Abrading



Milling



Shaping

Separating

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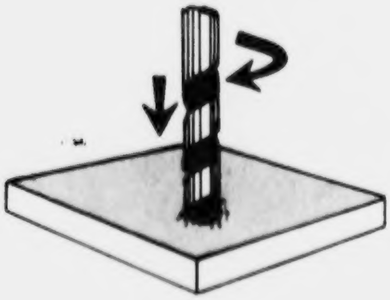
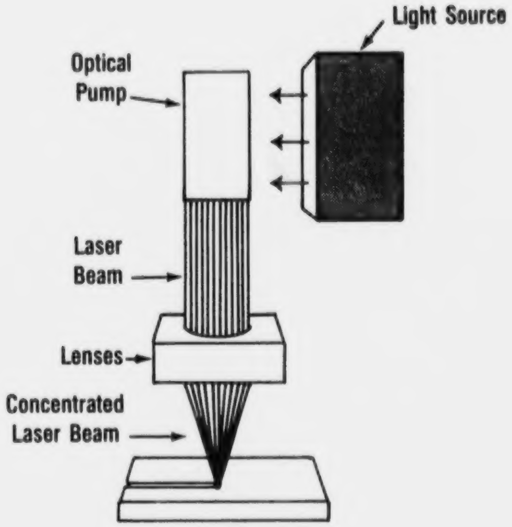
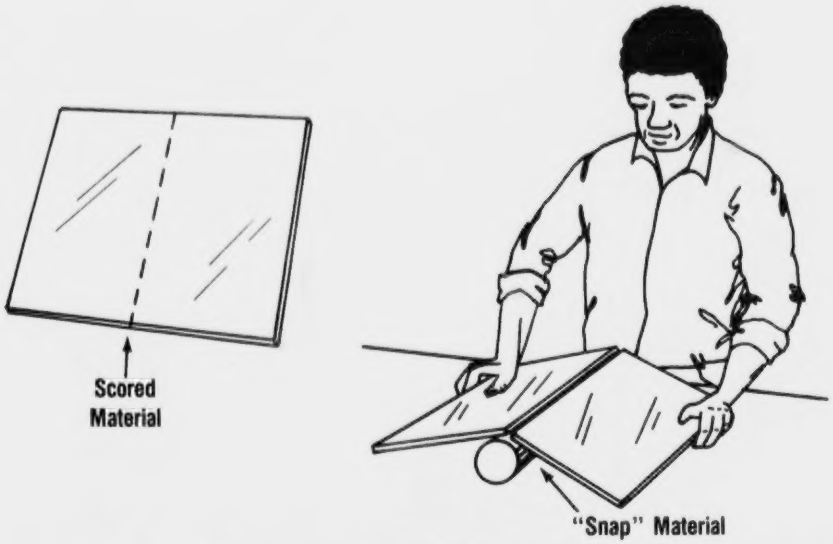


Drilling

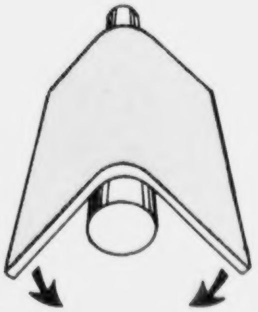

Light Source
Optical Pump
Laser Beam
Lenses
Concentrated Laser Beam

Laser Beam Machining

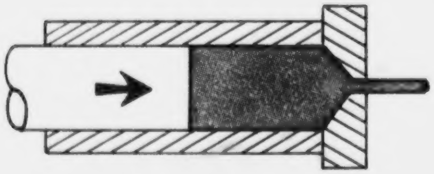

Scored Material
"Snap" Material

Induced-Fracture

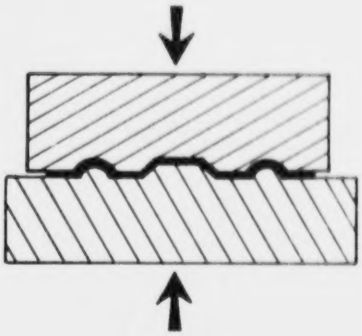
Forming



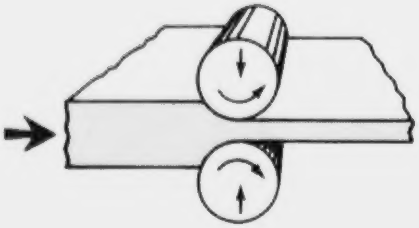
Bending



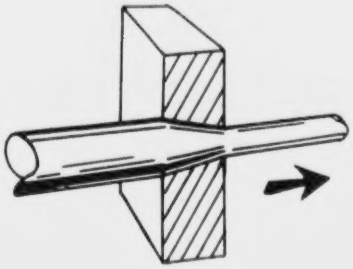
Extrusion



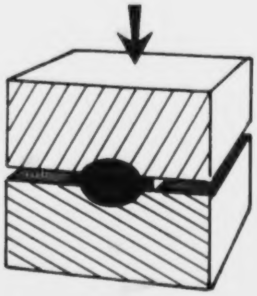
Pressing



Rolling



Drawing



Forging

Forming

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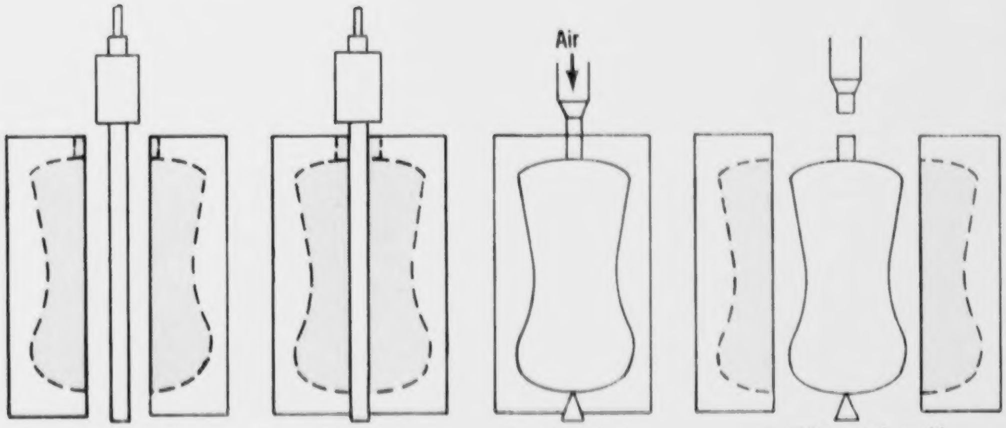
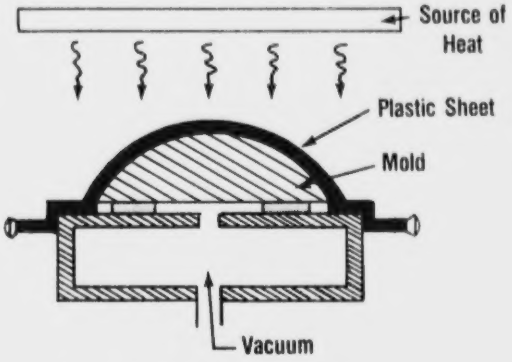
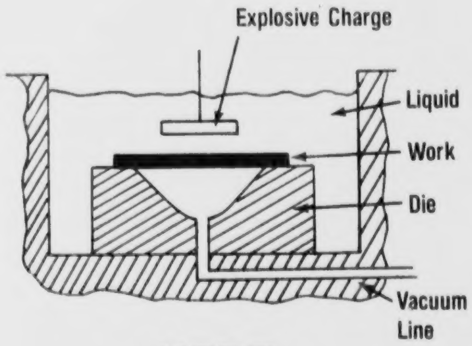


1. Heated plastic (parison) is placed between mold halves.
2. Mold closes.
3. Injected air forces plastic against mold sides.
4. When cool, mold opens and product is ejected.

Blow Molding

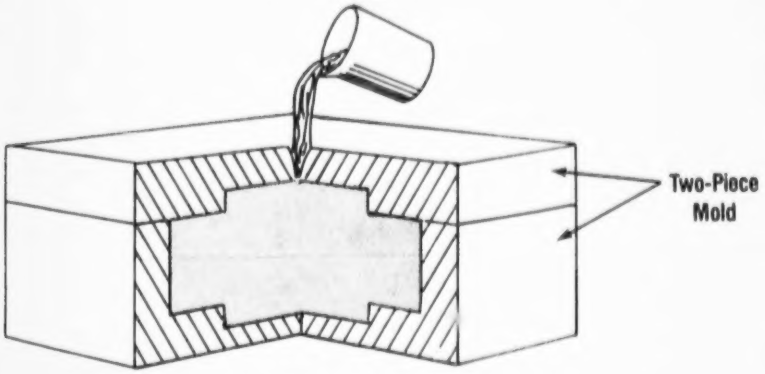

Source of Heat
Plastic Sheet
Mold
Vacuum

Thermoforming

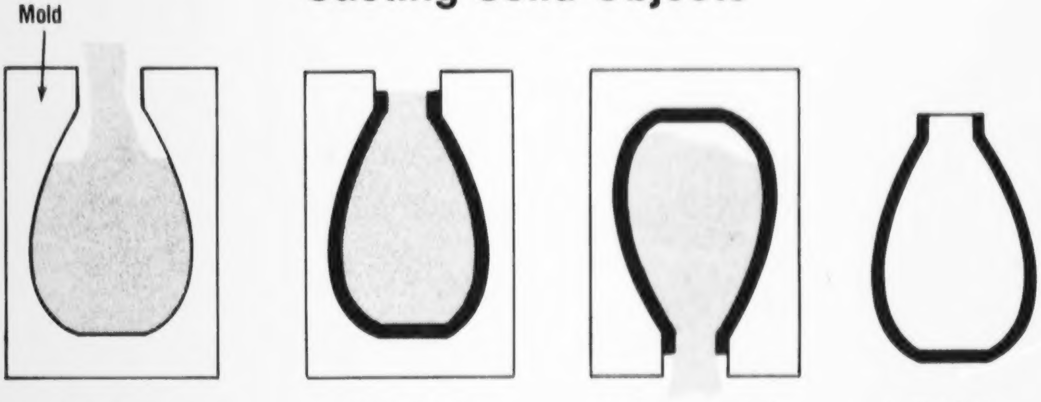

Explosive Charge
Liquid
Work
Die
Vacuum Line

HERF (Explosion Forming)

Casting

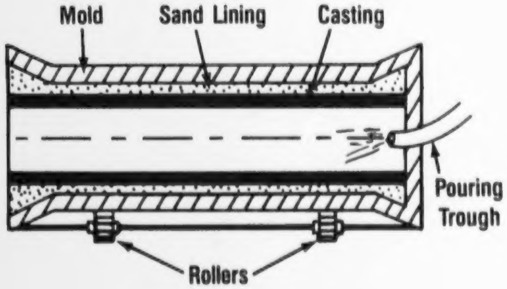

Two-Piece Mold

Casting Solid Objects

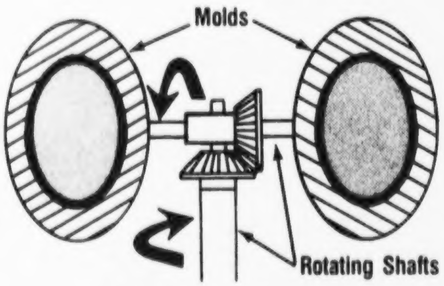


1. Mold is filled with plastisol.
2. Mold is heated to form walls of object.
3. Excess plastisol is poured out.
4. Finished object.

Casting Hollow Objects

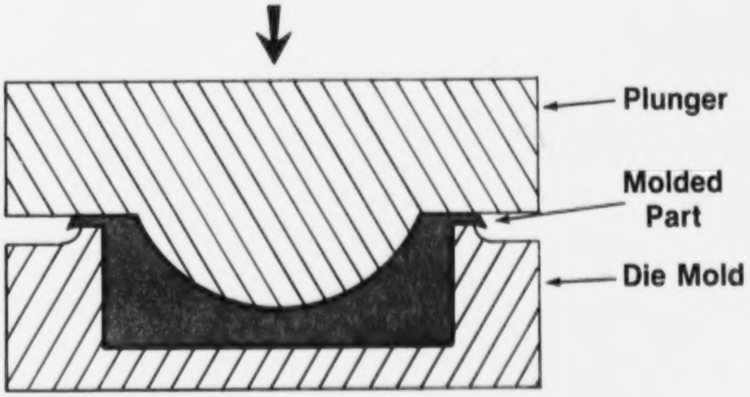

Mold
Sand Lining
Casting
Pouring Trough
Rollers

Casting Using Centrifugal Force

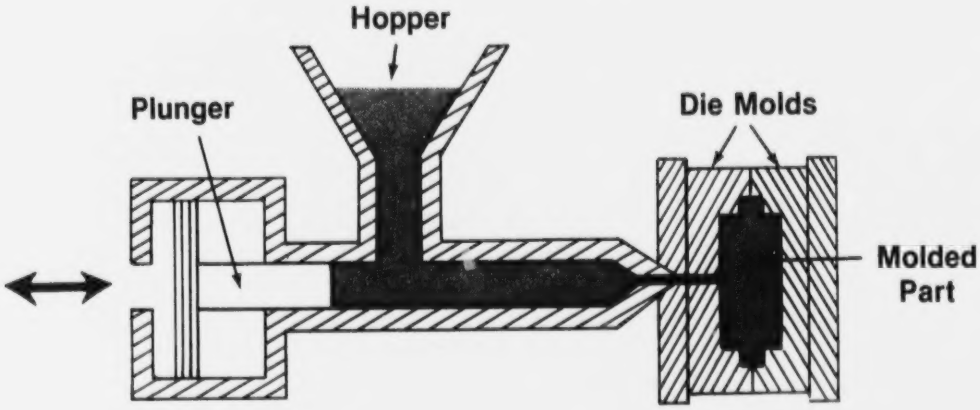

Molds
Rotating Shafts

Casting Using Rotational Force

Molding


Plunger
Molded Part
Die Mold

Compression Molding


Hopper
Plunger
Die Molds
Molded Part

Injection Molding

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #1 — COMPLETE A CROSSWORD PUZZLE OF "MANUFACTURING PROCESSES" TERMINOLOGY

NAME ____________________________ SCORE ______________________

Directions: This crossword puzzle reviews some of the terminology discussed in this unit. Carefully review the clues and fill in the appropriate blanks. This activity should be done in *pencil*.

Evaluation: There are 25 answers to be completed, therefore each correct answers is worth four points. The instructor will provide the grading scale for this assignment. A minimum score of 80% is required for this activity.

Correct	**Score**
25	100
24	96
23	92
22	88
21	84
20	80

ASSIGNMENT SHEET #1

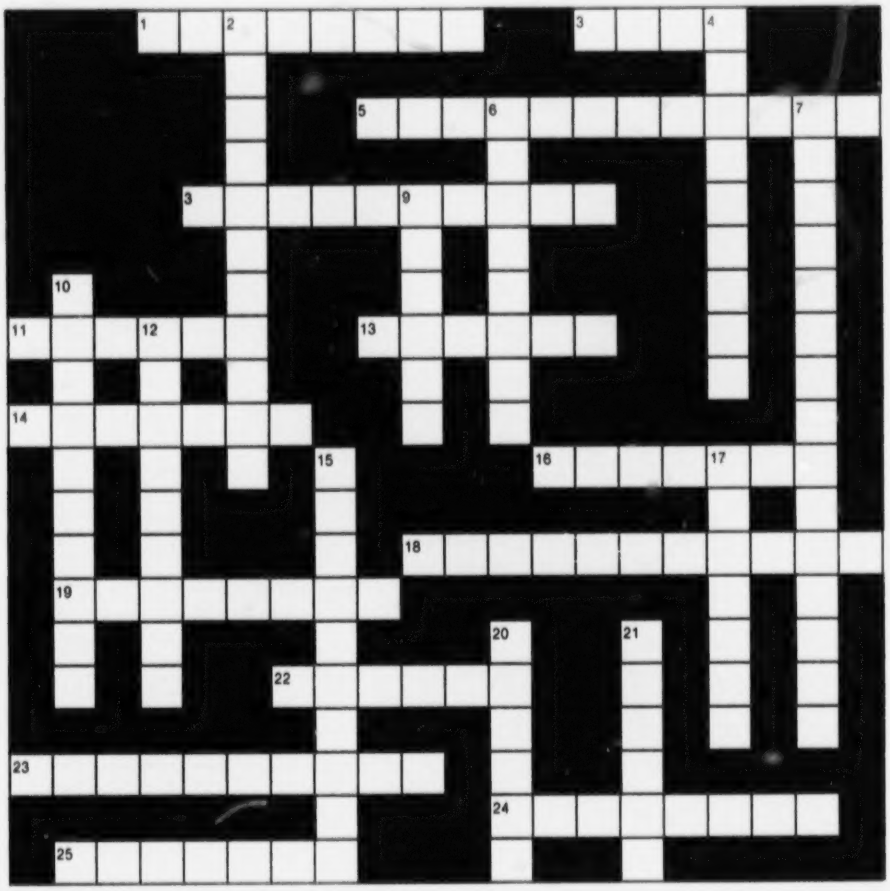
ACROSS CLUES

1. Cutting by wearing away material, usually by the action of mineral particles.
3. High energy rates, explosives, causes material to conform to the shape of the mold.
5. Secondary process that changes the internal structure of the material.
8. The gathering of mature, renewable raw materials from the earth.
11. Makes steel less brittle; thermal process.
13. The digging of holes in a series of tunnels to acquire raw materials.
14. Primary process where heat is used to harden or soften material.
16. Processing used products so they can be used in the manufacturing of new products.
18. Wood flour molding and powder metallurgy are associated with ______________-type molding.
19. Adding catalyst to a liquid material to make it harden; a primary process.
22. Make material hard; thermal process.
23. When parts are brought together so that they stay together for a definite period of time.
24. Fastening like or unlike materials together with an additional material.
25. Changing the size or shape of a material, but not the volume.

DOWN CLUES

2. Natural materials that are used to manufacture products; trees, coal, iron ore, and water.
4. Any operation or treatment done to protect or decorate a product.
6. Narrow, round shafts put into the earth, through which liquids or gasses are pumped to the surface.
7. Materials that can be found in nature.
9. Cutting with a tool having pointed teeth spaced along the edge of the blade.
10. Work hardening of metal is an example of a ______________ process.
12. Type of mechanical fastener in which the product can not be disassembled.
15. Removing excess material to produce a desired shape, size, or finish.
17. Pouring a liquid material into a mold and allowing it to harden before removal.
20. To soften material for forming or cutting.
21. A screwdriver blade is a product that is drop-______________.

ASSIGNMENT SHEET #1


1
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25

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #2 — IDENTIFY PRODUCTS WHICH HAVE BEEN FORMED

NAME ______________________________ SCORE ______________________

Directions: Find three items used around your home which you think were manufactured by different forming processes. Describe the items below and try to identify the material from which each was made and the specific forming process used.

ITEM 1: ____

____

Material: ____

Forming Process: ____

ITEM 2: ____

____

Material: ____

Forming Process: ____

ITEM 3: ____

____

Material: ____

Forming Process: ____

If possible, bring one of the items with you to class to have the instructor and other students help identify the material and forming process.

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #3 — IDENTIFY PRODUCTS WHICH HAVE BEEN CAST OR MOLDED

NAME ______________________________ SCORE ______________________

Directions: Find three items used around your home which you think were manufactured by different casting or molding processes. Describe the three items below and try to identify the material from which each was made and the specific casting or molding process used.

ITEM 1: ____

____

Material: ____

Casting Process: ______________________________________

ITEM 2: ____

____

Material: ____

Casting Process: ______________________________________

ITEM 3: ____

____

Material: ____

Casting Process: ______________________________________

If possible, bring one of the items with you to class to have the instructor and other students help identify the material and casting process.

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #4 — SURVEY THE SCHOOL LABORATORY FOR SECONDARY PROCESSES AND ASSOCIATE THEM WITH THE MAJOR INDUSTRIAL MATERIAL

NAME ______________________ SCORE ____________________

Many processes are discussed in this unit. Many of these processes are associated with one or more of the major manufacturing materials.

Directions: Your assignment is to list all the processes that can currently be done in your laboratory in the appropriate spaces. Underline those processes you have had opportunity to use in your technology classes so far. This will serve as a review of the processes section of this unit and provide information to be used in Unit V.

Evaluation: You will be evaluated on both the completeness, and correct placement of responses, as well as the neatness of your work.

	WOODS	METALS	PLASTICS	EARTH	COMPOSITES
Separating					
Forming					

ASSIGNMENT SHEET #4

	WOODS	METALS	PLASTICS	EARTH	COMPOSITES
Casting					
Conditioning					
Assembling					

ASSIGNMENT SHEET #4

	WOODS	METALS	PLASTICS	EARTH	COMPOSITES
Finishing					

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #5 — COMPLETE A SEPARATING PROCESS ANALYSIS CHART

NAME ____________________ SCORE ____________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #5

SEPARATING PROCESS ANALYSIS CHART

PART A: Identify	**Material Used**	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
	OPERATION **PROCESS ID**	Cut blade to length (screw driver)	Machine end of blade	Remove burrs	Remove sprue from handle	Removeexcess Smooth handle
	Sawing	0	0	0	0	0
	Shearing	0	0	0	0	0
	Turning	0	0	0	0	0
	Abrading	0	0	0	0	0
	Milling	0	0	0	0	0
	Shaping	0	0	0	0	0
	Drilling	0	0	0	0	0
	Induced Fracture	0	0	0	0	0
	Other:	0	0	0	0	0
PART B: Analysis	**CONCEPTS**					
CUTTING ELEMENT	Single-Point	0	0	0	0	0
	Multi-Point	0	0	0	0	0
	Other:					
	Flame	0	0	0	0	0
	Elec. Spark	0	0	0	0	0
	Chemical	0	0	0	0	0
	Light	0	0	0	0	0
	Sound	0	0	0	0	0
	Other	0	0	0	0	0
MOVEMENT	**Cutting Motion**	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work
	Reciprocating	0	0	0	0	0
	Rotary	0	0	0	0	0
	Linear	0	0	0	0	0
	Feed Motion	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work	0 Tool 0 Work
	Reciprocating	0	0	0	0	0
	Rotary	0	0	0	0	0
	Linear	0	0	0	0	0
HOLDING DEVICE	**Tool** (tool holder, chuck, bolt, arbor, collet, other)					
	Work (centers, faceplate, chuck, hold-downs, clamps, vise, etc.)					

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #6 — COMPLETE A FORMING PROCESS ANALYSIS CHART

NAME ____________________________ SCORE ______________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #6

FORMING PROCESS ANALYSIS CHART

PART A: Identify	**Material Formed**		0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
	OPERATION / **PROCESS ID**						
		Bending	0	0	0	0	0
		Extrusion	0	0	0	0	0
		Pressing	0	0	0	0	0
		Rolling	0	0	0	0	0
		Drawing (wire)	0	0	0	0	0
		Forging	0	0	0	0	0
		Blow Molding	0	0	0	0	0
		HERF	0	0	0	0	0
		Other:	0	0	0	0	0
PART B: Analysis	**CONCEPTS**						
	FORMING DEVICE	**Die**					
		Open	0	0	0	0	0
		One-Piece	0	0	0	0	0
		Mated or Closed	0	0	0	0	0
		Roll					
		Smooth (Straight)	0	0	0	0	0
		Shaped	0	0	0	0	0
	MATERIAL TEMP. (F)	Hot Forming (^{o}F)	0	0	0	0	0
		Cold Forming (^{o}F)	0	0	0	0	0
	SOURCE OF FORMING PRESSURE	**Machine Tool**					
		Hammer	0	0	0	0	0
		Press	0	0	0	0	0
		Rolling Machine	0	0	0	0	0
		Draw Bench	0	0	0	0	0
		Machine Force					
		Air Pressure	0	0	0	0	0
		Vacuum	0	0	0	0	0
		High Energy Rate	0	0	0	0	0
		Other	0	0	0	0	0

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #7 — COMPLETE A CASTING AND MOLDING PROCESS ANALYSIS CHART

NAME ______________________________ SCORE ______________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #7

CASTING/MOLDING PROCESS ANALYSIS CHART

PART A: Identify

Material Cast	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
OPERATION **PROCESS ID**					
Casting (Solid)	0	0	0	0	0
Casting (Hollow - Poured - Out)	0 0	0 0	0 0	0 0	0 0
Casting (Use Rotation)	0	0	0	0	0
Molding (Compression-type)	0	0	0	0	0
Molding (Injection-type)	0	0	0	0	0
Other	0	0	0	0	0

PART B: Analysis

	CONCEPTS					
MOLD	**Mold Life**					
	Expendable	0	0	0	0	0
	Permanent	0	0	0	0	0
	Mold Design					
	Single-Piece	0	0	0	0	0
	Multi-Piece	0	0	0	0	0
	Cores	0	0	0	0	0
	Mold Material					
	Mold Prep.					
	Pre-heated	0	0	0	0	0
	Release Agents	0	0	0	0	0
Material Preparation	Melt Dissolve Compound	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Intro into Mold	Pour (Gravity) Force	0 0	0 0	0 0	0 0	0 0
MaterialSolidificat.	Cool Chemical Action Dry	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0
Product Removal	Open Mold Destroy Mold	0 0	0 0	0 0	0 0	0 0

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #8 — COMPLETE A CONDITIONING PROCESS ANALYSIS CHART

NAME ____________________________ SCORE ______________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #8

CONDITIONING PROCESS ANALYSIS CHART

PART A: Identify

Material Conditioned	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
OPERATION **PROPERTY DESIRED**					
Hardness	0	0	0	0	0
Strength	0	0	0	0	0
More Ductility	0	0	0	0	0
More Elasticity	0	0	0	0	0
Stiffness	0	0	0	0	0
Toughness	0	0	0	0	0
Other:	0	0	0	0	0

PART B: Analysis

CONCEPTS

METHODS		0 Mechanical 0 Thermal 0 Chemical	0 Mechanical 0 Thermal 0 Chemical	0 Mechanical 0 Thermal 0 Chemical	0 Mechanical 0 Thermal 0 Chemical	0 Mechanical 0 Thermal 0 Chemical
MECHANICAL	Hammer	0	0	0	0	0
	Press	0	0	0	0	0
	Roll	0	0	0	0	0
	Other	0	0	0	0	0
THERMAL	**Heat Source**					
	Burning Gases (Flame)	0	0	0	0	0
	Mechanical (Friction)	0	0	0	0	0
	Electric	0	0	0	0	0
	Other	0	0	0	0	0
	Temperature					
	Length of Time					
	Cool. Medium					
	Water	0	0	0	0	0
	Liquid Solution	0	0	0	0	0
	Air	0	0	0	0	0
	Other	0	0	0	0	0
CHEMICAL	**Gas**	0	0	0	0	0
	Liquid	0	0	0	0	0
	Solid	0	0	0	0	0

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #9 — COMPLETE AN ASSEMBLING PROCESS ANALYSIS CHART

NAME ______________________________ SCORE ______________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #9

ASSEMBLY PROCESS ANALYSIS CHART

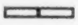
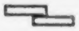
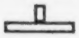
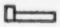
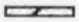
PART A:

Material Cast		0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
OPERATION ASSEMBLY						
MECHANICAL FASTENING	**Mechanical Fastener**					
	Permanent	0	0	0	0	0
	Semi-Permanent	0	0	0	0	0
	Temporary	0	0	0	0	0
	Mechanical Force					
	Seaming	0	0	0	0	0
	"Fitting"	0	0	0	0	0
	Other	0	0	0	0	0

PART B:

BONDING	**Bonding Agent**						
		Same	0	0	0	0	0
		Similar	0	0	0	0	0
		Dissimilar	0	0	0	0	0
	Bonding Method	**Adhesion or Cohesion**	0 Adhesion 0 Cohesion	0 Adhesion 0 Cohesion	0 Adhesion 0 Cohesion	0 Adhesion 0 Cohesion	0 Adhesion 0 Cohesion
		Heat	0	0	0	0	0
		Pressure	0	0	0	0	0
		Heat & Pressure	0	0	0	0	0
		Solvent	0	0	0	0	0
		Adhesives	0	0	0	0	0
		Other	0	0	0	0	0

PART C:

JOINTS						
Butt		0	0	0	0	0
Lap		0	0	0	0	0
"T"		0	0	0	0	0
Corner		0	0	0	0	0
Edge		0	0	0	0	0
Scarf		0	0	0	0	0
Other		0	0	0	0	0

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ASSIGNMENT SHEET #10 — COMPLETE A FINISHING PROCESS ANALYSIS CHART

NAME ____________________ SCORE ____________________

Instructions: As you complete each job sheet (Job Sheets #1-#7) you will complete the analysis chart as illustrated by the example in the first column. You will be evaluated upon the correct completion of the chart. Should you have any questions, ask your instructor.

ASSIGNMENT SHEET #10

FINISHING PROCESS ANALYSIS CHART

PART A:
Identify

Material Finished	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______	0 Wood 0 Plastics 0 Metals 0 Earth 0 Composites Kind: ______
Mfg Operation / OPERATION					
Basic Process Used to Change Surface					
Separating	0	0	0	0	0
Form/Cast/Molding	0	0	0	0	0
Conditioning	0	0	0	0	0
Assembly (Combining)	0	0	0	0	0

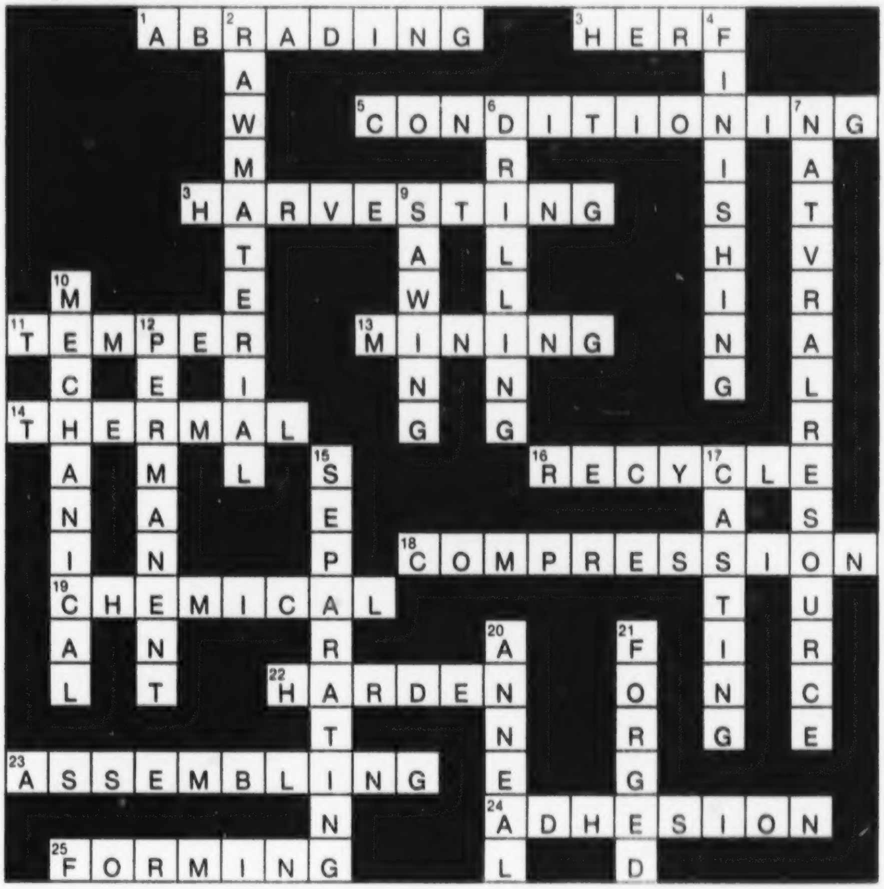
PART B:
Analysis

CONCEPTS						
FINISHING MATERIAL	**Convert. Surface**	0	0	0	0	0
	Coating					
	Metallic	0	0	0	0	0
	Non-Metallic	0	0	0	0	0
	None - Surface Altered	0	0	0	0	0
MATERIAL PREPARATION	Mechanically Clean	0	0	0	0	0
	Chemically Clean	0	0	0	0	0
	None Required	0	0	0	0	0
METHOD OF APPLICATION	**Chemical**	0	0	0	0	0
	Electrical	0	0	0	0	0
	Mechanical	0	0	0	0	0
	Dipping	0	0	0	0	0
	Spraying	0	0	0	0	0
	Rolling	0	0	0	0	0
	Brushing	0	0	0	0	0
	Other	0	0	0	0	0

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


1 ABRADING
2 RAWMATERIAL
3 HERF
4 FINISHING
5 CONDITIONING
6 DRILLING
7 NATVRALRESOURCE
3 HARVESTING
9 SAWING
10 MECHANICAL
11 TEMPER
12 PERMANENT
13 MINING
14 THERMAL
15 SEPARATING
16 RECYCLE
17 CASTING
18 COMPRESSION
19 CHEMICAL
20 ANNEAL
21 FORGED
22 HARDEN
23 ASSEMBLING
24 ADHESION
25 FORMING

Word List:

Abrading
Adhesion
Anneal
Assembling
Casting
Chemical
Conditioning
Compression
Drilling
Finishing
Forming
Forged
Harvesting
Harden
Herf
Mechanical
Mining
Natural resource
Permanent
Raw material
Recycle
Sawing
Separating
Temper
Thermal

Assignment Sheet #2-#10 — Evaluated to the satisfaction of the instructor

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #1 — CUT STEEL AND DROP FORGE A SCREWDRIVER BLADE

(NOTE: Before beginning this activity, be sure your instructor has demonstrated to you the proper use of the oxygen-acetylene torch and that you have been given permission to use it.)

A. Tools, equipment, materials, and supplies

1. Hacksaw
2. Vise
3. Drop forge
4. 7/16" box wrench
5. Stop with locking bolt
6. Hand screw (large)
7. Oxygen-acetylene torch outfit (including gloves and eye protection)
8. 12" steel rule
9. 1/4" × 6 1/2" round tool steel — 4140

B. Procedure

1. Cut the stock.
   a. Select 1/4" round tool steel stock.
   b. Mark stock 6 1/2" from the end.
   c. Clamp stock in vise in a horizontal position with 6 1/2" inch mark about 1" from the vise jaws.
   d. Cut the stock to length using a hacksaw. Apply pressure on forward stroke and cut about 30 strokes per minute.
   e. Keep 6 1/2" stock and return hacksaw and extra material.

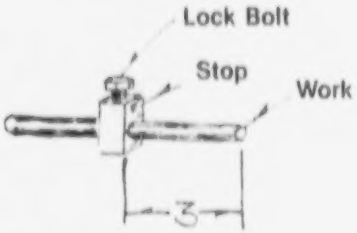
JOB SHEET #1

2. Prepare for forging.

   a. Get the 12" steel rule, 7/16" box wrench, and "stop" (usually located on the base of the drop forge).

   b. Fasten the work in the stop as shown in Figure 1. Use the 12" steel rule to accurately measure. Tighten the locking bolt with a 7/16" box wrench.

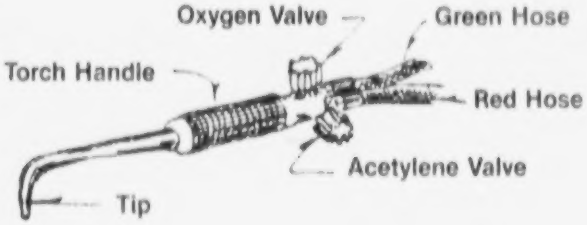
FIGURE 1



   c. Place the oxygen-acetylene cutting torch in the large hand screw as shown in Figure 2.

   (NOTE: Be sure you know how to properly use the oxygen-acetylene cutting torch and have the intructor's permission to use it.)

FIGURE 2



   d. Adjust the regulator valves according to your instructor's instructions. Be sure you are wearing proper gloves and eye protection.

3. Heat and forge.

   (NOTE: Read and understand all steps for this section before continuing. Do not do any work until you do so.)

   a. Locate someone to assist you by raising the hammer of the drop forge.

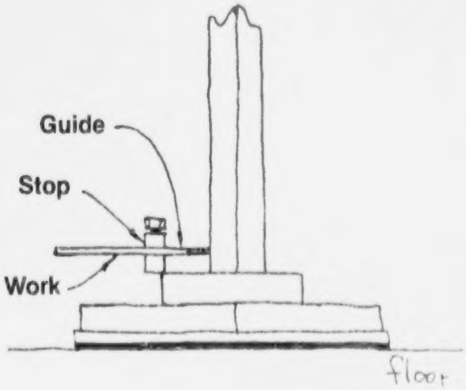
JOB SHEET #1

b. Light the torch and adjust to a neutral flame. Wear gloves and proper eye protection.

c. Hold one end of steel about 1" above the inner cone (white part) and start heating 1" from the end. Heat approximately 1 1/2" of the end to a bright red color. If sparks fly from the steel, move it away from the flame because the steel is burning.

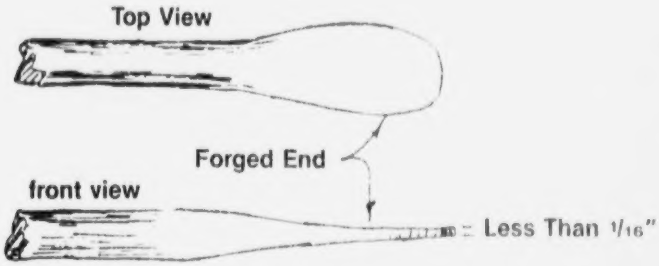
d. Place the heated steel in the drop forge as far as it will go and be sure the material is between the guides. KEEP STOP AGAINST THE END OF THE GUIDE AT ALL TIMES. Have your drop forging assistant raise the hammer and throw it down four times.

FIGURE 3



e. Remove the work and compare it to Figure 4. Reheat and reforge as needed. BE CAREFUL; STEEL IS STILL HOT!

FIGURE 4



JOB SHEET #1

f. Once work is to desired shape, clean up and put all tools away.

g. Have instructor inspect work for straightness.

(NOTE TO TEACHER: If it needs straightening, clamp the unforged portion in a machinist vise and bend it with a ball peen hammer.)

h. Refer to your notes and procedure. Complete the portions of Assignment Sheet #5 — Separating and Assignment Sheet #6 — Forming, which concern cutting and forging the screwdriver blade. Do all parts assigned by your instructor.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #2 — LAYOUT, GRIND SCREWDRIVER BLADE TO SHAPE, AND BEND

(**CAUTION:** Before starting these activities, be sure your instructor has demonstrated to you the proper use of the grinder and has given you permission to use it.)

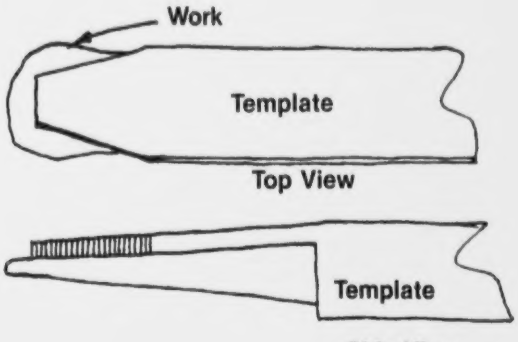
A. Tools, equipment, materials, and supplies

1. Screwdriver template
2. Machinist vise
3. Scriber
4. Grinder
5. 12" flat file
6. Ball peen hammer
7. 1/4" × 6 1/2" forged screwdriver blade
8. Layout dye
9. #10 flat or round head screw

B. Procedure

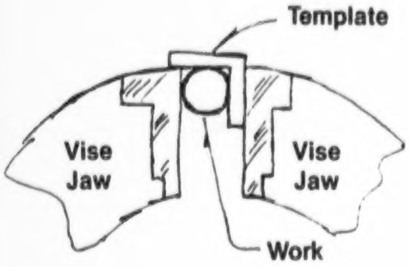
1. Layout blade.
    a. Get layout dye and screwdriver template.
    b. Apply layout dye to one of the forged surfaces and allow it to dry before continuing. Return layout dye.
    c. Position the template on the work (dye side against template) as shown in Figure 1 and clamp in vise as shown in Figure 2.

FIGURE 1



JOB SHEET #2

FIGURE 2



d. Carefully mark the blade by holding scriber as close to the edge of template as possible.

e. Return screwdriver template and scriber.

2. Grind blade to shape.

(NOTE: Get teacher's permission to use the bench grinder.)

a. Hold work firmly against the tool rest and grind the work to the scribed lines. DO NOT GRIND PAST THE LINES.

b. Have teacher inspect the work.

c. Remove burrs (thin rough edges caused by grinding) with a file. One or two passes with the file will be enough.

d. Obtain a #10 flat or round head screw of any length.

e. See if the end of screwdriver fits in the slot of the screw. If it will not, see your teacher and find out if you must reforge it.

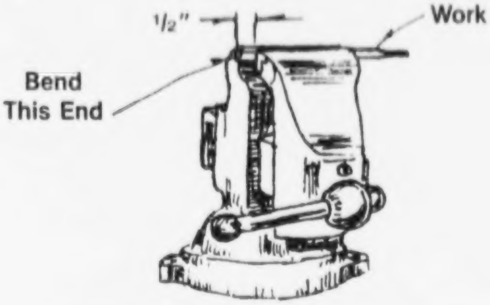
f. Put screw away.

JOB SHEET #2

3. Bend

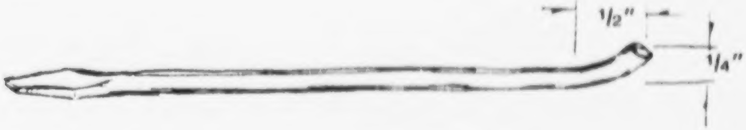
   a. Clamp the work in metalworking vise with *only* ½" sticking out as shown in Figure 3.

   FIGURE 3



   b. Obtain ballpeen hammer and use it to bend work sideways ¼" as shown in Figure 4.

   FIGURE 4



   c. Remove work from vise and put hammer away.

   d. Refer to your notes and procedure. Complete the portions of Assignment Sheet #5 — Separating and Assignment Sheet #6 — Forming.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #3 — PERFORM HEAT TREATMENT, HARDNESS TESTING, AND BEAD BLASTING OF SCREWDRIVER BLADE

A. Tools and equipment

1. Oxygen-acetylene outfit (including gloves and eye protection)
2. File
3. Oven
4. Glass bead blaster
5. Leather gloves
6. Liquid Tempilaq or Tempilaq marker (must indicate 1400°F)
7. 1 lb. coffee can of water
8. ¼" × 6 ½" screwdriver blade
9. Paper towel

B. Procedure

1. Prepare for heat treatment.
    a. Preheat oven to 475°F for later use.
    b. Obtain Tempilaq, water, and work and take to oxygen-acetylene outfit.
    c. Be sure to get permission from your teacher to use oxygen-acetylene torch.
2. Harden the steel.
    a. Shake the Tempilaq until it is completely mixed.
    b. Apply *one* drop of Tempilaq on the forged end of your work.
    c. Review oxygen-acetylene outfit's manual for operating instructions.
    d. Light and adjust torch for a neutral flame.
    e. Hold the forged end of your screwdriver about 1 ½ to 2 inches above the white part of the flame. Have the side with the Tempilaq up and the flame underneath. Start heating about ¾ to 1 inch from the end.

JOB SHEET #3

   f. As soon as the Tempilaq melts quickly stick the heated end in the water. Stir it around for about 30 seconds.

   g. Turn off the torch by closing both valves.

   h. Use a paper towel to remove water from the work.

   i. Put Tempilaq and OAW equipment away.

3. Test for hardness.

   a. Take the work and a file to the teacher.

   b. Teacher will demonstrate to you how the heat treatment has made it hard.

4. Temper the work.

   a. Place work in oven for a minimum of 15 minutes (longer is fine). Work on some assignments (see the last step of this job sheet) while you wait.

   b. Use leather gloves to remove work from oven and cool work in water or let it air cool.

   c. Turn off oven and put leather gloves away.

   d. Take file and work to the teacher. After tempering, it should be easier to file.

5. Perform glass bead blasting.

   a. Take work to glass bead blaster, place work inside, and close door.

   b. Check to see if exhaust hose is connected; connect it if necessary.

   c. Turn on vacuum cleaner switch and turn on the air. (Be sure it is connected.)

   d. Put your hands in the glass blaster's gloves and move the work around in the stream until thoroughly clean. After it is cleaned, lay it down and remove your hands from the gloves.

   e. Turn off the air and vacuum exhaust.

   f. Remove your work and be sure you close the blaster's door.

   g. Inspect your work.

   h. Refer to your notes and procedure. Complete the portions of Assignment Sheet #8 — Conditioning and Assignment Sheet #10 — Finishing.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #4 — TEST SCREWDRIVER BLADE USING LIQUID PENETRANT TESTING

A. Tools, equipment, materials, and supplies

1. Liquid penetrant cleaner
2. Dye penetrant
3. Penetrant developer
4. Two paper towels

B. Procedure

(NOTE: Use the liquid penetrant material in a well ventilated area. Hold can 6" to 12" from the work when spraying. The materials are expensive so do not waste them.)

1. Spray the cleaner on the forged end of the workpiece and wait 30 seconds.
2. Wipe the cleaner off with a paper towel and allow cleaner to dry one to two minutes.
3. Spray penetrant on the forged end of the work.

   (NOTE: DO NOT GET PENETRANT ON YOU OR ANYTHING ELSE.)
4. Shake developer thoroughly for one or two minutes until ball inside can is moving freely.
5. Wipe off all of the penetrant.
6. Spray a thin, damp coat of developer on your work.
7. Look carefully. Any cracks will be indicated by thin red lines.
8. Have your teacher inspect your work.
9. Use a wet paper towel to clean the developer from the screwdriver.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #5 — FINISH SCREWDRIVER BLADE USING "ELECTROLESS ELECTROPLATE"

A. Tools, equipment, materials, and supplies

1. Stove
2. Large pan
3. Polyethylene (gal jug)
4. Wood block
5. Wire brush
6. Power buffer
7. Water
8. Cleanser
9. Chemicals
10. Acetic acid
11. Alcohol

B. Procedure

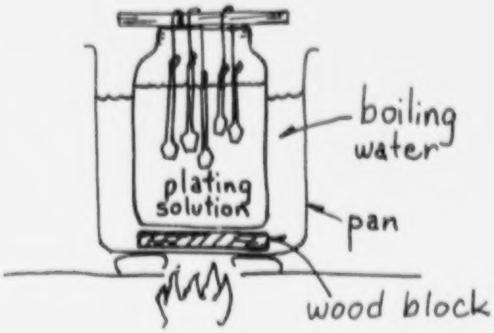
1. Prepare the part to be plated.
   a. Remove all scratches and scales by grinding and polishing.
   b. Remove zinc or cadmium plating from part so the part will plate.
2. Clean the part to be plated using brush or rag with an abrasive cleaner. All oil and dirt must be removed so the part is chemically clean. This is very important.

   (NOTE: Lacquer thinner or oven cleaners may be used to clean the part.)
3. Prepare plating apparatus.
   a. Place wood block in bottom of large pan.
   b. Fill the pan about ½ full of water, and place it on the stove.
   c. Put one gallon of water into the polyethylene plating tank. Tap water may be used, but distilled water will insure consistent performance.

JOB SHEET #5

d. Place plating tank on top of wood block in pan.

FIGURE 1



4. Prepare the plating solution.

   a. Preheat the water inside the tank.

   b. Add one envelope of chemicals to tank and stir until dissolved. One envelope of chemicals contains enough to make 1 gallon of plating solution.

   c. Add 1 ounce of acetic acid to solution.

   d. Heat plating solution to 200°F and maintain as near to 200°F as possible.

5. Plating the part.

   a. Directly from the cleansing rinse, suspend the part in the 200°F plating solution.

   (NOTE: Place as many parts as possible into solution because the chemicals work best the first time they are used. Successful plating is detected by the freeing of fine bubbles at the surface of the part. The plating will build up .0005 to .001 inch per hour.)

   (CAUTION: Do not allow parts to touch each other.)

   b. When the desired plate thickness is reached, remove the part from the solution.

   c. Rinse it with water and dry it with a soft cloth. Water spots can be eliminated by wiping the part with alcohol.

   (NOTE: The plating solution may be reheated and used until the chemicals are exhausted. However, it is desirable to use new plating solution for each set of parts. Water may be added to the pan to make up for evaporation.)

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #6 — MAKE A WEP HANDLE FOR SCREWDRIVER

(NOTE: Allow a *minimum* of 25 minutes to do this activity.)

A. Tools, equipment, materials, and supplies

1. Screwdriver mold
2. Mixer rod
3. Drill press (set at 1200 rpm)
4. Eye dropper
5. Screwdriver (regular slotted)
6. Water extended polyester (WEP) resin

   (NOTE TO INSTRUCTOR: WEP does have a shelf life. WEP over six months old may not harden properly.)

7. Catalyst
8. Newspaper
9. Paper towels
10. Tongue depressor, popsicle stick, or small mixing stick
11. 2 — 8 oz. paper measuring cups, *bottom diameter must be 2 inches or less*. If measuring cups are not available, mark one 8 oz. cup at 1 ½ ounces and the other at one ounce.
12. Can of water

B. Procedure

1. Mix water with the resin.

   a. Obtain all tools, equipment (except drill press), materials, and supplies listed above. Place newspaper on work area and put all materials on the newspaper.

   (NOTE: The following must be done in a well ventilated area.)

   b. Measure out 1 ounce of water by volume in one of the 8 oz. cups.

   c. Measure out 1 ½ ounces of WEP by volume in the other 8 oz. cup.

   d. Use a paper towel to wipe resin out of the lid and off of the can's spout. Replace the lid.

JOB SHEET #6

e. Chuck the mixer in the drill press and place a board on drill press table.

(NOTE: Be sure you have been instructed in the use of the drill press and have your instructor's permission to use it.)

f. Adjust the drill press to its lowest speed (rpm).

g. Place a newspaper on the board on the drill press table.

h. Lower the mixer into the cup of WEP resin until it touches bottom and raise it up to about 1/4" from the cup's bottom. Lock the quill. DO NOT HAVE DRILL PRESS RUNNING.

i. Put the cup of water and eyedropper on the drill press table.

j. Read and understand all of this step before doing any work.

  1) Hold onto cup and start drill press.

  2) Use eyedropper to add the water to the resin as it mixes.

  3) After all water has been added, stop the drill press and increase speed to about 1200 rpm and mix for at least 1 minute.

  4) Stop the machine.

  CAUTION: Never raise the mixer while the drill press is running because it will throw material over everything.

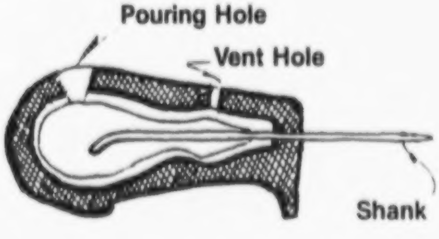
k. Unlock quill, raise the mixer, remove the mixer, and clean it thoroughly with water.

l. Move everything back to original work area.

2. Prepare the mold.

  a. Remove the screws holding the mold halves together and place the screwdriver blade in the mold as shown in Figure 1. Notice that the unforged end of the blade (bent part down) is about even with the pouring hold (sprue).

FIGURE 1



JOB SHEET #6

b. Put mold halves together with a screwdriver. Be sure you can see the end of the work through the pouring hole.

c. Place mold on newspaper with pouring hole up.

3. Have instructor add the catalyst.

   a. Have instructor use eyedropper to add 15-20 drops (not squirts) of catalyst to the water/resin mixture.

      (NOTE TO INSTRUCTOR: WEP without catalyst left in the molds may ruin the mold. Old catalyst is not as effective as new. Molds should harden in less than one hour.)

   b. Use tongue depressor or mixing stick to mix the catalyst with the mixture for *one minute*.

   c. Slowly pour mixture into the mold until it is completely filled.

   d. Vibrate the mold to remove air bubbles by raising it slightly and striking it several times.

4. Clean-up.

   a. Flush the eye dropper with water by filling it several times with water and emptying it. *This step is very important* to future success by fellow students.

   b. Put all tools and materials away. The cup that had water in it can be reused, but the resin cup should be discarded. Be sure lids are on the resin and catalyst tightly.

   c. Leave the resin in the mold until it is solid. Time varies with the weather, resin, and catalyst. Sometimes it is ready in 30 minutes. You will probably leave it until next class period.

   d. Refer to your notes and procedure. Complete the appropriate portion of Assignment Sheet #7 — Casting and Molding.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

JOB SHEET #7 — TRIM THE HANDLE AND FINISH THE SCREWDRIVER

A. Tools, equipment, materials, and supplies

1. Screwdriver (slotted)
2. Wire cutters ("dikes")
3. 80-grit sandpaper
4. 120-grit sandpaper
5. Gelled stain
6. Waste rag or paper towel
7. Polyurethane varnish
8. #0000 steel wool

B. Procedure

1. Remove the work.
    a. Use screwdriver to remove bolts and take mold apart.
    b. Remove the "screwdriver", put the mold back together, and put all items away.
    c. Allow screwdriver to cure at least overnight *after pouring*, before continuing to next step.
2. Trim the handle.
    a. Use wire cutters to trim off sprue (pour hole part) and riser (vent hold part).
    b. Use a small piece of 80-grit abrasive paper to remove remainder of sprue and riser.
    c. Use a small piece of 120-grit abrasive paper to smooth up any rough spots. Do not sand so much as to sand the wood grain pattern off.
3. Finish the work.
    a. Get a can of gelled stain and a *small* piece of waste rag or paper towel.
    b. Wipe the gelled stain onto the handle. It will not hurt if you get some on the steel. DO NOT get it on you or your clothes.

JOB SHEET #7

c. Put the lid back on the can.

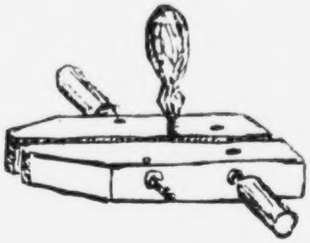
d. Use a small waste rag or paper towel to wipe the stain off of the handle.

e. Discard all of the dirty rags and paper towels in an oily waste container.

f. Allow the screwdriver to dry overnight.

g. Clamp the screwdriver in a small parallel clamp as shown in Figure 1.

FIGURE 1



h. Fold a paper towel and use it to wipe a light coat of polyurethane varnish on the handle.

i. If you put on too much, it will run.

j. Close the varnish container.

k. Discard the towel in an oily waste container.

l. Allow the varnish to dry overnight.

m. Rub the varnish with a small piece of fine steel wool.

n. Repeat steps h through l.

(NOTE: You will have a better finish on the handle if you repeat Steps h through l. DO NOT use steel wool after the *last* coat. This is optional. It depends on how much time you need for your other projects.)

o. Use a small piece of steel wool to remove any stain or varnish from the metal part of the screwdriver.

p. Put a thin coating of oil on the metal part of the screwdriver.

q. Refer to your notes and procedure. Complete the appropriate portions of Assignment Sheet #5 — Separating, and Assignment Sheet #10 — Finishing.

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MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #1 — CUT STEEL AND DROP FORGE A SCREWDRIVER BLADE

STUDENT'S NAME ______________________________ DATE STARTED ______________

EVALUATOR'S NAME ____________________________ DATE COMPLETED ______________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.	______	______
2. Cut stock to proper length (6 1/2").	______	______
3. Located side of stop 3" from end of workpiece.	______	______
4. Set-up and adjusted OAW torch properly.	______	______
5. Heated the end of workpiece properly for forging.	______	______
6. Drop forged workpiece to proper thickness (less than 1/16") and shape.	______	______
7. Inspected workpiece for straightness.	______	______
8. Put away tools and materials.	______	______
9. Cleaned the work area.	______	______
10. Used proper tools correctly.	______	______
11. Used laboratory time wisely in completing this activity.	______	______
12. Practiced safety rules throughout procedure.	______	______
13. Provided satisfactory responses to questions asked.	______	______
14. Completed portions of appropriate assignment sheets as directed.	______	______

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #1 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
Workpiece is correct length (6 1/2")	4	3	2	1
Workpiece end is correct thickness (less than 1/16")	4	3	2	1
Workpiece is free of temperature damage (not burnt or formed too cold)	4	3	2	1
Workpiece is straight	4	3	2	1

EVALUATOR'S COMMENTS: ____

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #2 — LAYOUT, GRIND SCREWDRIVER BLADE TO SHAPE, AND BEND

STUDENT'S NAME ____________________ DATE STARTED __________

EVALUATOR'S NAME ____________________ DATE COMPLETED __________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.	______	______
2. Scribed (marked) the layout of the screwdriver blade using template and scriber.	______	______
3. Ground the work to the scribed lines.	______	______
4. Had teacher inspect the work.	______	______
5. Removed the burrs with a file.	______	______
6. Fitted the screwdriver to the slot of a #10 wood screw.	______	______
7. Bent shaft of screwdriver blade 1/2" from end, and 1/4" sideways from centerline.	______	______
8. Put away tools and materials.	______	______
9. Cleaned the work area.	______	______
10. Used proper tools correctly.	______	______
11. Used laboratory time wisely in completing this activity.	______	______
12. Practiced safety rules throughout procedure.	______	______
13. Provided satisfactory responses to questions asked.	______	______
14. Completed portions of appropriate assignment sheets as directed.	______	______

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #2 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

Blade is of uniform shape (symmetrical), like template	4	3	2	1
Blade tip is free of burrs	4	3	2	1
Blade tip is proper width and thickness (fits #10 wood screw slot properly	4	3	2	1
Shaft of blade is bent at correct location (1/2" from end)	4	3	2	1
Shaft of blade is bent sideways 1/4" from centerline	4	3	2	1

EVALUATOR'S COMMENTS: ____

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #3 — PERFORM HEAT TREATMENT, HARDNESS TESTING, AND BEAD BLASING OF SCREWDRIVER BLADE

STUDENT'S NAME ____________________ DATE STARTED ____________

EVALUATOR'S NAME ____________________ DATE COMPLETED ____________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.		
2. Preheated oven to 475°F.		
3. Mixed Tempilag and applied 1 drop to end of blade.		
4. Lighted and adjusted torch for a neutral flame.		
5. Heated the forged end of screwdriver till Tempilag melts.		
6. Quenched the busted end in the water and stirred it around for 30 seconds.		
7. Tested workpiece for hardness with a file (teacher).		
8. Heated workpiece in oven for 15 minutes to temper blade.		
9. Checked workpiece with file to test tempering (teacher).		
10. Used glass bead blaster properly to completely clean workpiece.		
11. Put away tools and materials.		
12. Cleaned the work area.		
13. Used proper tools correctly.		
14. Used laboratory time wisely in completing this activity.		
15. Practiced safety rules throughout procedure.		
16. Provided satisfactory responses to questions asked.		
17. Completed portions of appropriate assignment sheets as directed.		

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #3 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

Workpiece hardened sufficiently (file test #1)	4	3	2	1
Workpiece tempered, not brittle (file test #2)	4	3	2	1
Workpiece cleaned completely, uniform appearance	4	3	2	1

EVALUATOR'S COMMENTS: ____

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #4 — TEST SCREWDRIVER BLADE USING LIQUID PENETRANT TESTING

STUDENT'S NAME ______________________ DATE STARTED __________

EVALUATOR'S NAME ______________________ DATE COMPLETED __________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.	______	______
2. Applied cleaner to workpiece.	______	______
3. Wiped cleaner off after 30 seconds and allowed to dry for 2 minutes.	______	______
4. Applied penetrant and allowed two minutes to penetrate.	______	______
5. Wiped off penetrant.	______	______
6. Applied thin layer of developer, after shaking it thoroughly.	______	______
7. Inspected workpiece for surface defects.	______	______
8. Removed developer from the workpiece.	______	______
9. Put away tools and materials.	______	______
10. Cleaned the work area.	______	______
11. Used proper tools correctly.	______	______
12. Used laboratory time wisely in completing this activity.	______	______
13. Practiced safety rules throughout procedure.	______	______
14. Provided satisfactory responses to questions asked.	______	______

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #4 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
Product free of defects	4	3	2	1
Product free of developer residue	4	3	2	1

EVALUATOR'S COMMENTS: ____

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #5 — FINISH SCREWDRIVER BLADE USING "ELECTROLESS ELECTROPLATE"

STUDENT'S NAME ____________________ DATE STARTED __________

EVALUATOR'S NAME ____________________ DATE COMPLETED __________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.		
2. Removed all scratches and scale from workpiece.		
3. Cleaned the workpiece of all oil and dirt.		
4. Set-up plating apparatus (usually done by teacher).		
5. Prepared plating solution (usually done by teacher).		
6. Plated part.		
7. Put away tools and materials.		
8. Cleaned the work area.		
9. Used proper tools correctly.		
10. Used laboratory time wisely in completing this activity.		
11. Practiced safety rules throughout procedure.		
12. Provided satisfactory responses to questions asked.		
13. Completed portions of appropriate assignment sheets as directed.		

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #5 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

Part is plated uniformly (free of blemishes [e.g. oil residue spots])	4	3	2	1
Part is plated to sufficient thickness	4	3	2	1
Plating adheres to surface of workpiece (free of scaling)	4	3	2	1
Part plated so handle will cover any part of blade not plated	4	3	2	1

EVALUATOR'S COMMENTS: ______________________________

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #6 — MAKE A WEP HANDLE FOR SCREWDRIVER

STUDENT'S NAME ____________________ DATE STARTED __________

EVALUATOR'S NAME ____________________ DATE COMPLETED __________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:		YES	NO
1.	Obtained proper tools and materials.	______	______
2.	Mixed 1 oz. of water to 1 $1/2$ oz. of resin according to directions.	______	______
3.	Prepared mold by placing screwdriver in mold with bent part of blade end about even with sprue and printing down.	______	______
4.	Put mold halves together with screwdriver.	______	______
5.	Had instructor add catalyst (15-20 drops) to resin/water mixture and stirred for 1 minute.	______	______
6.	Poured mixture slowly into mold until completely full.	______	______
7.	Vibrated mold to remove air bubbles by raising it slightly and striking it.	______	______
8.	Put away tools and materials.	______	______
9.	Cleaned the work area.	______	______
10.	Used proper tools correctly.	______	______
11.	Used laboratory time wisely in completing this activity.	______	______
12.	Practiced safety rules throughout procedure.	______	______
13.	Provided satisfactory responses to questions asked.	______	______
14.	Completed portions of appropriate assignment sheets as directed.	______	______

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #6 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
(See practical test #7 — product is not ready for evaluation until Job Sheet #7 is started.)				

EVALUATOR'S COMMENTS: ____

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

MANUFACTURING PROCESSES AND SELECTION
UNIT IV

PRACTICAL TEST
JOB SHEET #7 — TRIM THE HANDLE AND FINISH THE SCREWDRIVER

STUDENT'S NAME ______________________ DATE STARTED ____________

EVALUATOR'S NAME ______________________ DATE COMPLETED ____________

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Obtained proper tools and materials.	______	______
2. Removed screwdriver from the mold.	______	______
3. Allowed screwdriver handle to cure.	______	______
4. Trimmed the handle.	______	______
5. Applied stain.	______	______
6. Removed excess stain.	______	______
7. Discarded oily rags in oily waste container.	______	______
8. Allowed screwdriver to dry overnight.	______	______
9. Clamped screwdriver in small wooden handscrew.	______	______
10. Applied a light coat of polyurethane varnish on the handle.	______	______
11. Allowed varnish to dry overnight.	______	______
12. Rubbed varnish with steel wool (this should not have been done on last coat).	______	______
13. Repeated finishing steps as necessary to achieve desired finish.	______	______
14. Applied thin coating of oil to metal blade screwdriver.	______	______
15. Put away tools and materials.	______	______
16. Cleaned the work area.	______	______
17. Used proper tools correctly.	______	______
18. Used laboratory time wisely in completing this activity.	______	______
19. Practiced safety rules throughout procedure.	______	______
20. Provided satisfactory responses to questions asked.	______	______
21. Completed portions of appropriate assignment sheets as directed.	______	______

EVALUATOR'S COMMENTS: ____

____

JOB SHEET #7 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria: (first four apply to Job Sheet #6)				
Handle is totally complete	4	3	2	1
Handle is free of gas bubbles or pockets	4	3	2	1
Handle is hard and dry, not soft and sticky	4	3	2	1
Blade sticks out of the handle the proper length	4	3	2	1
Surfaces prepared properly for finish (no scratches, rough areas, or places where wood grain detail has been removed)	4	3	2	1
Stain and finish is uniform	4	3	2	1
Surfaces feel smooth	4	3	2	1
Overall appearance—color, shape	4	3	2	1

EVALUATOR'S COMMENTS: ______________________________

____

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

EMT- 285

MANUFACTURING PROCESSES AND SYSTEMS
UNIT IV

TEST

NAME ____________________ SCORE ____________________

1. Match the terms related to manufacturing processes with their correct definitions.

_____a. Natural combination of minerals from which metals can be extracted (example: bauxite)

_____b. Process of removing impurities from materials

_____c. Materials which can be converted by manufacturing or processing into a new and useful product (example: timber)

_____d. Metal cast into a form that can be melted or reshaped into another metal product

_____e. Reprocessing of waste materials into useful products

1. Ingots
2. Natural resources
3. Ore
4. Recycle
5. Raw materials
6. Refining

2. Arrange the stages in material processing in their proper order by placing a "1" by the first stage, "2" by the second stage, etc. for each stage listed.

_____a. Produce industrial materials

_____b. Produce finished goods

_____c. Recycle or dispose of unwanted materials

_____d. Acquire raw materials

3. Complete statements concerning the three major processes for acquiring raw materials by placing the number(s) of the best answer(s) in the appropriate blanks.

_____a. The three major processes for acquiring raw materials are:
1) Excavation
_____b. 2) Drilling
3) Mining
_____c. 4) Siphoning
5) Harvesting

TEST

______d. Cutting wood (lumbering), picking cotton, and shearing sheep would be examples of:
1) Excavation
2) Drilling
3) Mining
4) Siphoning
5) Harvesting

______e. The digging of holes in the earth or a series of tunnels to acquire raw materials such as iron ore and bauxite is called:
1) Excavation
2) Drilling
3) Mining
4) Siphoning
5) Harvesting

______f. The process of extracting oil and natural gas from the earth is most closely associated with:
1) Excavation
2) Drilling
3) Mining
4) Siphoning
5) Harvesting

4. Complete statements concerning primary processes for converting natural resources into standard stock, by placing the number(s) of the best answer(s) in the proper blanks.

______a. The three major categories of primary processes are:
1) Chemical
______b. 2) Electrical
3) Fluid
______c. 4) Mechanical
5) Thermal

______d. Forming polymers (plastics), tanning leather, and refining aluminum are examples of ______________ processing:
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

______e. Separating ore by melting and steelmaking are most closely associated with ______________ processing:
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

TEST

_____f. Rock crushing and manufacturing lumber are most closely associated with ____________ processing:
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

5. Match secondary processes with their correct definitions.

_____a. Protecting or decorating a product

_____b. Removing excess material to produce desired size or shape

_____c. Changing the size or shape of a material but not the volume

_____d. Bringing parts together so they stay together for a definite period of time

_____e. Pouring or forcing material in liquid form into a mold

_____f. Changing the internal structure of materials to give desired properties

1. Assembling
2. Casting and molding
3. Conditioning
4. Finishing
5. Forming
6. Manufacturing
7. Separating
8. Sizing

6. Complete statements concerning the three elements of separating by placing the number(s) of the correct answer(s) in the appropriate blanks.

_____a.
_____b.
_____c.

The three (3) elements of separating include:
1) Forming device
2) Movement
3) Source of pressure
4) Support or clamping
5) Tool or cutting element

_____d. Vises, hold-downs, and chucks are most closely associated with:
1) Forming device
2) Movement
3) Source of pressure
4) Support or clamping
5) Tool or cutting element

_____e. Rotary, reciprocating, and linear actions, as well as "feed," are most closely associated with:
1) Forming device
2) Movement
3) Source of pressure
4) Support or clamping
5) Tool or cutting element

TEST

______f. Electrical areas, chemical action, flame, and multiple points or single points, are most closely associated with:
1) Forming device
2) Movement
3) Source of pressure
4) Support or clamping
5) Tool or cutting element

7. Match the separating processes with their descriptions or examples.

______a. Cutting glass by first scoring a line

______b. Cutting by moving a single-edge tool across a fixed work-piece in a straight-line cutting path

______c. Cutting to form or enlarge a hole using a cylindrical, rotating tool

______d. Examples include grinding, sanding, and high pressure water jet machinery

______e. Machines used include wood jointers and surfacers (planes); a hand tool example is the file

______f. EDM, laser beam machining, and flame cutting are examples

______g. The lathe is principally used for this process

______h. Paper punches and scissors are examples of tools used

______i. Cutting with a tool with teeth equally spaced along the edge of a blade

1. Abrading
2. Drawing
3. Drilling
4. Electrical, chemical thermal erosion
5. Forging
6. Induced-fracture
7. Milling
8. Sawing
9. Shaping
10. Shearing
11. Turning

8. Complete statements concerning the three major elements of the forming process by placing the number(s) of the correct answer(s) in the appropriate blanks.

______a. The three major elements of the forming process are:
1) Forming device
______b. 2) Movement
3) Source of pressure
______c. 4) Temperature of material
5) Tooling or material removal element

TEST

_____d. Air, vacuum, explosives, electromagnets, hand tools, and machines are most closely associated with the _____________ element.

1) Forming device
2) Movement
3) Source of pressure
4) Temperature of material
5) Tooling or material removal element

_____e. Two devices that determine the final shape of the product in the forming process are:

_____f.

1) Air bags
2) Dies
3) Drills
4) Rolls
5) Magnets

_____g. "Material formed below the lowest temperature it can be formed without causing internal stress," describes _____________ materials.

1) Cold-formed
2) External-formed
3) Hot-formed
4) Internal-formed
5) Pressure-formed

9. Match the forming processes with their descriptions or examples.

_____a. Generally used to produce sheets; calendering plastics is an example

_____b. Use of compressive force or repeated blows to shape workpiece; making a screwdriver blade

_____c. Explosive forming metal is an example

_____d. Process used to produce glass and plastic bottles

_____e. Squeezing sheet metal between two dies to form desired shape; an example is embossing license plates

_____f. Process of using force to form heated plastic sheets to contour of mold; an example is vacuum forming signs

1. Bending
2. Blow molding
3. Drawing
4. Extrusion
5. Forging
6. HERF
7. Milling
8. Pressing
9. Rolling
10. Shaping
11. Thermoforming-type process

TEST

______g. Process used to make plastic pipe and tubing; squeezing toothpaste from a tube illustrates this

______h. Forming sheetmetal with a bar folder is an example

______i. Process used to produce wire; result is decrease in cross-sectional area and increase in length

10. Complete statements concerning the sequential elements of casting and molding by placing the number(s) of the correct answer(s) in the appropriate blanks.

______a. The five sequential elements of casting and molding are:
1) Solidification of material
______b. 2) Support or clamping
3) Introduction of material into mold
______c. 4) Product (casting) removal from mold
5) Casting or molding material preparation
______d. 6) The mold

______e.

______f. Three methods used to prepare material to be cast or molded are:
1) Abrading
______g. 2) Compounding
3) Dissolving
______h. 4) Melting
5) Sizing

______i. Three ways material solidifies inside a mold are:
1) Chemical action
______j. 2) Dissolving
3) Drying
______k. 4) Hardening
5) Steaming

______l. Molds which can be used over and over again to produce quantity items are called ____________ molds:
1) Disposable
2) One-shot
3) Permanent

TEST

_____m. When forces and pressure are used in addition to gravity to fill a mold, the type of process is called:
1) Casting
2) Molding

_____n. To remove the casting of a screwdriver handle made in an aluminum mold lined with silicone RTV, the mold is:
1) Opened
2) Destroyed

11. Match the casting/molding processes with their descriptions or examples.

_____a. Examples include slush casting and slip casting

_____b. Casting in which part is formed on the outside of the mold

_____c. Example: Lost wax process, lost foam process

_____d. Centrifugal casting of pipe; making hollow plastic balls

_____e. Examples include die casting, injection molding

_____f. Casting process in which metal or other materials are poured into a mold, and the casting is removed without destroying the mold after it has solidified.

_____g. Metal casting process in which mold is destroyed to remove casting; mold is made of aggregate material

_____h. Examples include wood flour molding, powder metallurgy (sintering)

1. Investment casting
2. Forging
3. Cast hollow objects (excess poured out)
4. Compression-type molding
5. Injection-type molding
6. Casting using rotation
7. Impact-type molding
8. Sand casting
9. Dip casting
10. Permanent molding

12. Select from the following list the major considerations for determining conditioning processes by placing an "X" in the appropriate blanks.

_____a. Determine external appearance requirements

_____b. Determine steps for changing outside of material

_____c. Establish the mechanical property requirements of material

_____d. Determine internal structure required to obtain desired properties

_____e. Select steps to accomplish internal change

TEST

13. Select from the following list the three major reasons for conditioning materials by placing an "X" in the appropriate blanks.

_____a. Change external characteristics

_____b. Make material easier to form or separate

_____c. Remove internal stresses

_____d. Impart certain properties

_____e. Improve appearance

14. Complete statements concerning types of conditioning processes by placing the number(s) of the best answer(s) in the appropriate blanks.

_____a. The three major types of conditioning processes are:
1) Chemical
_____b. 2) Electrical
3) Fluid
_____c. 4) Mechanical
5) Thermal

_____d. Drying wood, firing ceramics, and annealing metals to improve the physical and mechanical properties describes ____________ conditioning.
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

_____e. Using pounding or squeezing action to change the internal structure describes ____________ conditioning.
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

_____f. Adding yeast to bread dough, stabilizers to plastic, or adding manganese to molten steel are examples of ____________ conditioning.
1) Chemical
2) Electrical
3) Fluid
4) Mechanical
5) Thermal

TEST

15. Match typical conditioning methods used with the various materials with their descriptions or examples.

_____a. Process used to soften wood so it can be bent or shaped without breaking

_____b. Different elements are added to metal to improve their mechanical properties and processing characteristics

_____c. Air and kilns are used to condition wood in this process

_____d. Earth materials are placed into a kiln to alter their chemical structure (e.g. producing bisque from greenware)

_____e. Example: Removing stresses in machined parts

_____f. Outer layer of metal is made hard while inside core remains relatively soft

_____g. Soften metals for forming or separating

_____h. Ingredient added to plastics to speed up chemical action

1. Activators
2. Alloying
3. Annealing
4. Case hardening
5. Catalyst
6. Color change
7. Drying (seasoning)
8. Firing
9. Normalizing
10. Steaming
11. Tempering

16. Complete statements concerning the essential elements of assembling by placing the number(s) of the correct answer(s) in the appropriate blanks.

_____a. Materials are held together by either ____________ or ____________ (major categories):
_____b. 1) Electrical assembly
2) Bonding
3) Friction
4) Mechanical fastening

_____c. The permanent assembly method which holds parts together using pressure, heat, and/or agent is called:
1) Electrical assembly
2) Bonding
3) Friction
4) Mechanical fastening

TEST

_____d. Permanent fastening by fusing like materials together through localized melting or softening describes a(n) ____________ assembly method.
1) Adhesion
2) Mechanical force
3) Mechanical fastening
4) Electrical seaming
5) Cohesion

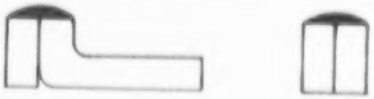
_____e. Wood held together by glue and copper pipe and couplings held together by solder are two examples of a(n) ____________ assembly method.
1) Adhesion
2) Mechanical force
3) Mechanical fastening
4) Electrical seaming
5) Cohesion

_____f. Permanent, semi-permanent, or temporary assembly with devices such as nails, screws, rivets, bolts, and safety pins, describes the use of:
1) Adhesion
2) Mechanical force
3) Mechanical fasteners
4) Electrical seamers
5) Cohesion

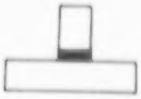
_____g. "Shrink fits," "snap fits,", "press fits," and interlocking groove seams of sheet metal are all examples of assembly by:
1) Adhesion
2) Mechanical force
3) Mechanical fasteners
4) Electrical seamers
5) Cohesion

17. Identify the following joints by matching their designs with their names.

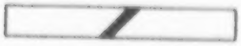
_____a.



_____b.

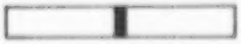


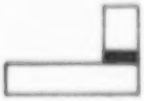
_____c.



1. Butt
2. Corner (metals)
3. Dado
4. Edge (metals)
5. Lap
6. Rabbit
7. Scarf
8. "T" (metals)

TEST

_____d. 

_____e. 

18. Select true statements regarding finishing and its relationship to the other secondary processes by marking "T" for true statements and "F" for false statements.

_____a. Finishing is the process of applying a treatment to the outside surface of the materials.

_____b. Finishing is done to improve the appearance and/or protect the surface of the product or part.

_____c. Finishing is actually a process which makes use of the other secondary process in achieving its desired results.

_____d. Knurling, peening, and embossing are examples of finishing processes that utilize the casting and molding processes.

_____e. Buffing, sand blasting, incising, and etching are examples of finishing processes that utilize the separating process.

_____f. Painting and flocking are examples of finishing processes that utilize the forming process.

19. Complete statements concerning the essential elements in finishing processes by placing the number(s) of the best answer(s) in the proper blanks.

_____a. The three (3) essential elements in finishing are:
1) Preparation of base material
_____b. 2) Removal of finish
3) Application of finish
_____c. 4) Refinishing of material
5) Selection of finishing material

_____d. An addition of a second layer of material to the surface of the base metal and not removing it is known as:
1) Anodizing
2) Blacking
3) Coating
4) Facing
5) Texturing

TEST

_____e. The two principal methods of improving the smoothness and cleanliness of a material prior to putting finish on it are _____________

_____f. and ___________ preparation.

1) Mechanical
2) Electrical
3) Fluid
4) Chemical
5) Transfer

_____g. "Pickling" and abrasives are *most closely* associated with the:

1) Preparation of base material
2) Selection of finishing material
3) Powder coating of finish
4) Application of finish
5) Electrostatic process

_____h. Dip coating, spray coating, roll coating, and brush coating are categorized as ___________ methods of applying a finish.

1) Mechanical
2) Electrical
3) Pneumatic
4) Chemical
5) Hydraulic

20. Select true statements concerning the types of metallic coatings and platings by marking "T" for true statements and "F" for false statements.

_____a. Two examples of conversion coatings are anodized coatings and oxide coatings.

_____b. Gold, silver, and chrome are typically applied with brushes.

_____c. The material applied to the inside of food containers is lead.

_____d. Flame spraying and plasma-arc spraying are examples of metallizing.

_____e. Galvanized steel is plated with zinc to prevent rust.

TEST

21. Select true statements concerning general safety rules for manufacturing by placing a "T" next to true statements and an "F" next to false statements

_____a. Obtain instructor's approval after operating any power equipment.

_____b. Wear eye protection only when operating a machine.

_____c. Remove jewelry and confine loose clothing and long hair when working in the laboratory.

_____d. Never operate a machine if over-tired or ill.

_____e. Turn power on before making any adjustments on the machine.

_____f. Always feed material into machine before machine reaches its full operating speed.

_____g. Keep machine tables and working surfaces clear of tools, stock, and other materials.

_____h. Hands should be kept a minimum distance of one inch from the cutting tool.

_____i. Inform the instructor immediately if a machine is not working properly.

_____j. Only talk to one person at a time when operating a machine.

_____k. Never leave a machine running unattended.

_____l. Be sure machine's power switch is turned on when oiling or adjusting a machine.

_____m. Use a machine for all operations, no matter how trivial.

_____n. Use a machine only after receiving proper instruction and permission of the instructor.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

22. Complete a crossword puzzle of "manufacturing processes" terminology. (Assignment Sheet #1)

23. Identify products which have been formed. (Assignment Sheet #2)

24. Identify products which have been cast or molded. (Assignment Sheet #3)

25. Survey the school laboratory for secondary processes and associate them with the major industrial material. (Assignment Sheet #4)

TEST

26. Complete a separating process analysis chart. (Assignment Sheet #5)
27. Complete a forming process analysis chart. (Assignment Sheet #6)
28. Complete a casting and molding process analysis chart. (Assignment Sheet #7)
29. Complete a conditioning process analysis chart. (Assignment Sheet #8)
30. Complete an assembling process analysis chart. (Assignment Sheet #9)
31. Complete a finishing process analysis chart. (Assignment Sheet #10)
32. Demonstrate the ability to:
    a. Cut steel and drop forge a screwdriver blade. (Job Sheet #1)
    b. Layout, grind screwdriver blade to shape, and bend. (Job Sheet #2)
    c. Perform heat treatment, hardness testing, and bead blasting of screwdriver blade. (Job Sheet #3)
    d. Test screwdriver blade using liquid penetrant testing. (Job Sheet #4)
    e. Finish screwdriver blade using "electroless electroplate." (Job Sheet #5)
    f. Make a WEP handle for screwdriver. (Job Sheet #6)
    g. Trim the handle and finish the screwdriver. (Job Sheet #7)

MANUFACTURING PROCESSES AND SYSTEMS
UNIT IV

ANSWERS TO TEST

1.	a.	3								
	b.	6								
	c.	5								
	d.	1								
	e.	4								
2.	a.	2								
	b.	3								
	c.	4								
	d.	1								
3.	a.	2	any order			d.	5			
	b.	3				e.	3			
	c.	5				f.	2			
4.	a.	1	any order			d.	1			
	b.	4				e.	5			
	c.	5				f.	4			
5.	a.	4		d.	1					
	b.	7		e.	2					
	c.	5		f.	3					
6.	a.	2	any order			d.	4			
	b.	4				e.	2			
	c.	5				f.	5			
7.	a.	6		e.	7	i.	8			
	b.	9		f.	4					
	c.	3		g.	11					
	d.	1		h.	10					
8.	a.	1	any order			d.	3		g.	1
	b.	3				e.	2	any order		
	c.	4				f.	4			

ANSWERS TO TEST

9. a. 9
b. 5
c. 6
d. 2
e. 8
f. 11
g. 4
h. 1
i. 3

10. a. 1
b. 3 any
c. 4 order
d. 5
e. 6
f. 2 any
g. 3 order
h. 4
i. 1 any
j. 3 order
k. 4
l. 3
m. 2
n. 1

11. a. 3
b. 9
c. 1
d. 6
e. 5
f. 10
g. 8
h. 4

12. c, d, e

13. b, c, d

14. a. 1 any
b. 4 order
c. 5
d. 5
e. 4
f. 1

15. a. 10
b. 2
c. 7
d. 8
e. 9
f. 4
g. 3
h. 5

16. a. 2 any
b. 4 order
c. 2
d. 5
e. 1
f. 3
g. 2

17. a. 4
b. 8
c. 7
d. 1
e. 2

ANSWERS TO TEST

18.	a.	T	d.	F
	b.	T	e.	T
	c.	T	f.	F

19.	a.	1	any order	e.	1	any order
	b.	3		f.	4	
	c.	5		g.	1	
	d.	3		h.	1	

20.	a.	T
	b.	F
	c.	F
	d.	T
	e.	T

21.	a.	F	f.	F	k.	T
	b.	F	g.	T	l.	F
	c.	T	h.	F	m.	F
	d.	T	i.	T	n.	T
	e.	F	j.	F		

22.-31. Evaluated to the satisfaction of the instructor

32. Performance skills evaluated to the satisfaction of the instructor

150
Total Points

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to list factors used in identifying and designing a manufacturing product and distinguish between the divisions in a manufacturing firm that performs these tasks. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to identifying and designing a product with the correct definitions.
2. Differentiate between the major functions of research and development.
3. Distinguish between the two types of research.
4. Complete statements concerning the two processes of research and development.
5. Select from a list the main types of professionals involved in research and development.
6. Select from a list the functions of development.
7. Complete statements concerning product development.
8. Complete statements concerning the two approaches to developing new products.
9. Complete statements concerning the sources of product ideas.

OBJECTIVE SHEET

10. Select from a list the major factors considered in designing a product.
11. Select from a list the main elements in a product profile.
12. Arrange in order the steps in product development.
13. Complete statements concerning market research and development.
14. Complete statements concerning process development.
15. Select from a list the definition and purpose of product engineering.
16. Complete statements concerning the areas of product engineering.
17. Select from a list the criteria that guide product selection.
18. Design a product that can be mass produced by your class. (Assignment Sheet #1)
19. Complete a product profile for the prototype. (Assignment Sheet #2)
20. Conduct a market survey for the prototype. (Assignment Sheet #3)
21. Complete a bill of materials for the prototype. (Assignment Sheet #4)

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

  1. As the class narrows down the choices of products, begin to introduce the idea of selling stock in the class corporation.
  2. The company management should have stock certificates prepared by the end of this unit.
  3. Provide opportunities for groups or individuals to make presentations of prototype products.
  4. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

A. Heiner, Carl W. and Wayne R. Hendrix. *People Create Technology.* Worcester, MA: Davis Publications, Inc., 1980.

B. *Industrial Education: Materials & Processes*, C.B.I.E. Project, Kansas State Department of Education, Topeka, 1986.

REFERENCES USED IN DEVELOPING THIS UNIT

C. *Iowa High School Curriculum — Manufacturing.* Iowa State University, The State Department of Education, Des Moines, 1972.

D. Wright, R. Thomas and Richard M. Henak. *Exploring Technology*. South Holland, IL: Goodheart-Willcox Co., 1972.

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

INFORMATION SHEET

I. **Terms and definitions**

  A. Ideation — A process where many ideas are sketched on paper, and the best ones are selected

  B. Market research — Determines who and where the customer is, what the customer needs and wants, what the customer will buy, and how much the customer will pay for a product

  C. Mock-up — An appearance model, normally made of cardboard, paper, plaster, clay, or other easy to work with materials

  D. Models — Final prototypes or mock-ups that include all design changes

  E. Product profile — Initial screening tool in seeking product ideas; gives direction and sets limits for arriving at ideas

  F. Prototype — Working models that show a full-sized working product of the same material that the final product will use

  G. Research and development (R&D) — Developing and refining ideas leading to new or improved products, processes, and materials

  H. Thumbnail sketches — Serve the same purpose as notes for writers; assorted pieces of information, later sorted and organized into more complete pictures

II. **Major functions of research and development** (Transparency 1)

  A. Research — Scientifically seeking and discovering knowledge

  B. Development — Applying knowledge gained from research to develop new and improved products and processes

  C. Product development — Testing product designs and planning for production

III. **Types of research** (Transparency 2)

  A. Pure or basic research — Exploring nature to seek knowledge or information without consideration of commercial application

  B. Applied research — Solving specific problems facing a company, usually having direct commercial applications

INFORMATION SHEET

IV. **Processes of research and development**

   A. Collection of data — Information collected during the research process

   B. Laboratory testing — Techniques and procedures are evaluated and experimented with in a laboratory situation

V. **Professionals involved in research and development**

   A. Scientists

      Example: Metallurgist

   B. Engineers

      Example: Mechanical engineer

VI. **Functions of development** (Transparency 3)

   A. Looks for economical applications of the results of research

   B. Concerned with designing new and improved products and processes

VII. **Product development**

   A. Creates and tests product designs

   B. Is a subdivision of development and reviews and evaluates all possible design ideas for a product

   C. Develops those designs that appear to have the greatest potential

   D. Has major goals of developing products that:

      1. Will be *profitable*

      2. Will *meet or beat the competition*, and

      3. Are *wanted by customers*

VIII. **Companies' approaches to developing new products**

   A. Production approach — Develop innovative new products first and then convince consumers they need them

   B. Consumer approach — Determine the needs of the consumer first and then develop products to meet them

INFORMATION SHEET

IX. **Sources of product ideas**

A. Consumer research — Market research is used to determine consumers' needs and wants.

B. Technological development — New materials and processes resulting from technological advancements are a source for new products.

Example: Graphite tennis rackets

C. Competitive awareness — Companies get ideas from their competitors. In many cases, because patents have not been obtained or have expired, companies can legally imitate "hot selling" products. They can also make subtle design changes to avoid violating patents.

Example: Ideas for a product may come from seeing a product in a catalog or store.

D. Other sources

1. R & D personnel
2. Sales representatives
3. Other company personnel
4. Customers
5. Government agencies such as NASA and OSHA
6. Military
7. Inventors
8. Universities

X. **Three major factors considered in designing a product** (Assignment Sheet #1)

A. *Function* — Will it work? Can it do the job for which it is designed?

Example: An automobile that can reliably transport you from town to town

B. *Ability to be manufactured* — Can the company build it effectively?

C. *Marketability* — Will it sell? Do customers want the product, and will they buy it?

(NOTE: All three of these factors must be addressed by a successful company. Companies also must address *cost* and *competition* in the market.)

INFORMATION SHEET

XI. **Main elements in a product profile** (Handout #1 and Assignment Sheet #2)

A. Market considerations

1. Who is the market?
2. How big is the market?
3. Is there competition?

B. Product considerations

1. What is the product?
2. How can the product be used?
3. What is the product's life expectancy?

C. Production considerations

1. How difficult will the product be to manufacture?
2. What equipment is needed? Is it available and cost-efficient?
3. What materials are needed? Are they available and cost-efficient?
4. How much time and money must be allowed for tooling and set up?

D. Financial considerations

1. How much will manufacturing cost?
2. What is the selling price?
3. What is the profit margin?

XII. **Steps in product development** (Handouts #2, #3, and #4)

A. Preliminary designs are developed (thumbnail and rough sketches).

B. Refined sketches are made (renderings).

C. Mock-ups are made.

1. Paste-up mock-up — General size and shape using cardboard and Styrofoam®
2. Appearance mock-up — Looks like real thing but different material

INFORMATION SHEET

   3. Hard mock-up — Often uses same materials as final product will be made

D. Detailed sketches are made.

   1. Assembly drawings
   2. Detail drawings
   3. Schematic drawings

E. Prototypes are built.

F. Product is tested.

   1. Testing determines if product design has flaws.
   2. Also answers customers' (pilot group) complaints.

G. Market is tested.

XIII. **Market research and analysis** (Handouts #5 and #6 and Assignment Sheet #3)

A. Market research — The collecting, recording, and analyzing of facts related to the sale of products

B. Market survey is used to gather data about prospective customers.

   1. Who the product buyers are
   2. Background information on customer (demographics — where they live, age, education, etc.)
   3. How customers use product
   4. Where customers buy such a product
   5. How much the customer would pay for this kind of product
   6. Type of service expected by customer

C. Market analysis — Measuring and evaluating the extent and characteristics of market

INFORMATION SHEET

XIV. **Process development**

A. The process development group is responsible for planning systems or processes which produce the product.

B. The product development staff will work hand-in-hand with the process staff in order to reduce modifications or changes.

C. Before the product is produced, several questions must be answered. They include:

1. How many items are to be produced?
2. What standard of quality is desired?
3. What equipment is needed for production?
4. How is each part to be made, and on what type of machine?
5. What sequence of operations or processes will produce the product most economically?

XV. **Definition and purpose of product engineering** — The final refinement of product designs, through the use of specifications, standards, and testing, to make it ready for manufacturing.

(NOTE: At this point the plans may need to be altered in order to accommodate the mass production of the product.)

XVI. **Areas of product engineering**

A. Product design specification

1. Engineering drawings (Handouts #3 and #4)
    a. Detail drawings
    b. Assembly drawings
    c. Systems drawings
2. Specification sheets (specs) — Written description of item's characteristics which cannot be shown in a drawing
3. Bill of materials — List of materials necessary to manufacture a product. (Handout #7 and Assignment Sheet #4) Typically includes:
    a. Part number
    b. Part name (description, e.g. sides)

INFORMATION SHEET

- c. Quantity of each part
- d. Size — Thickness, width, length, volume, weight
- e. Material — Specific information

  Examples: Acrylic (instead of plastics), pine (instead of wood)

B. Engineering testing

1. Test and gather information about the performance of product under actual work conditions.
2. Evaluate quality and final appearance.
3. Check product in regard to ability to be serviced and repaired.

   Example: Must the automobile engine be removed to change spark plugs?

C. Consulting — Product engineers provide advice and information to production personnel in regard to manufacturing problems.

XVII. Criteria to guide product selection

- A. Market or consumer needs
- B. Function of the product
- C. Cost limitations
- D. Production facility limitations
- E. Skill of the labor force
- F. Time limitations

(NOTE: In most cases a product review/planning board is established that evaluates each idea and selects the idea or ideas that are most appropriate for manufacturing by the organization. See Transparency 4.)

Research and Development

Research

Scientifically seeking and discovering knowledge

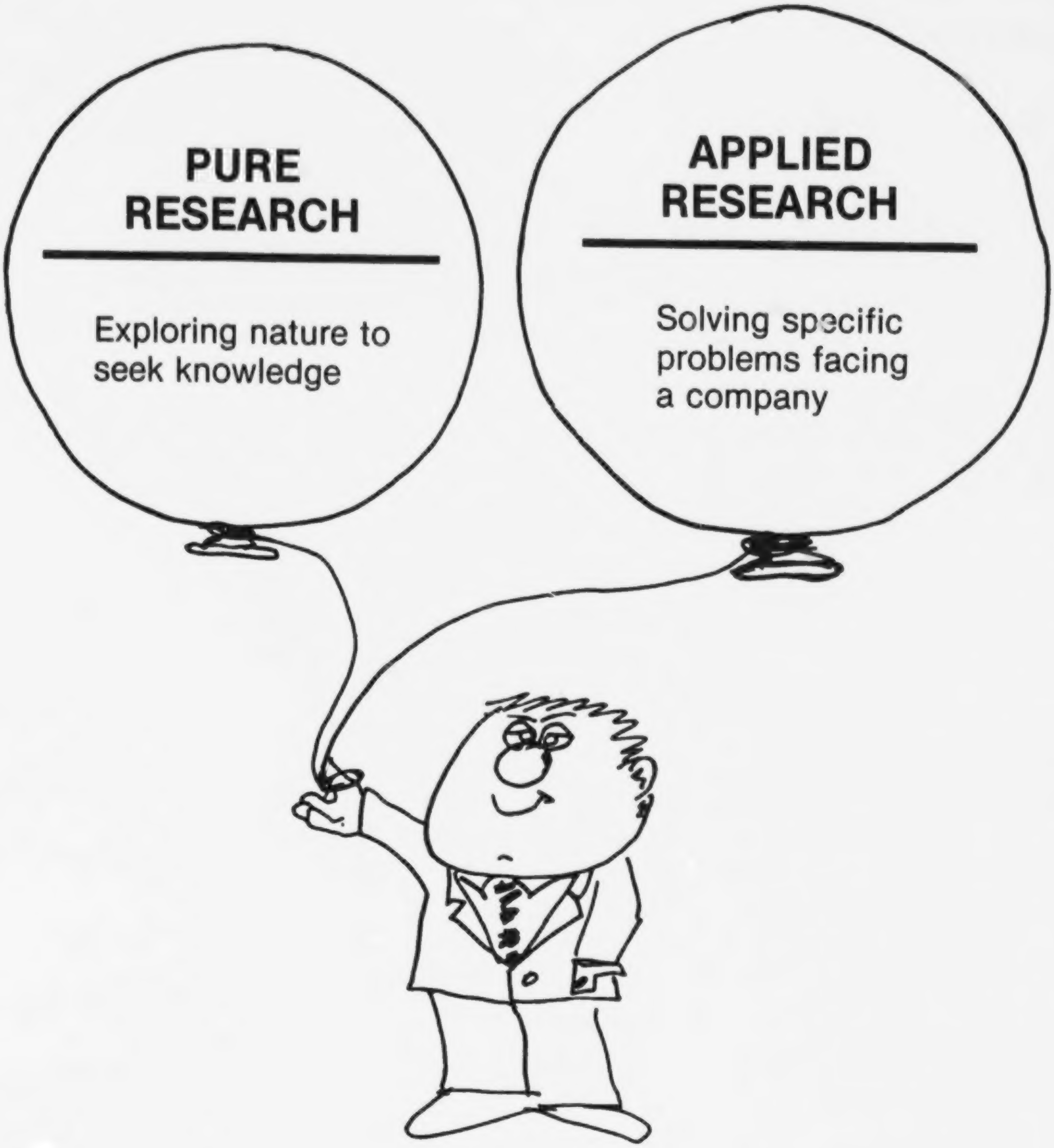
Development

Applying knowledge gained from research to develop new and improved products and processes

Product Development

Testing product designs and planning for production

Types of Research



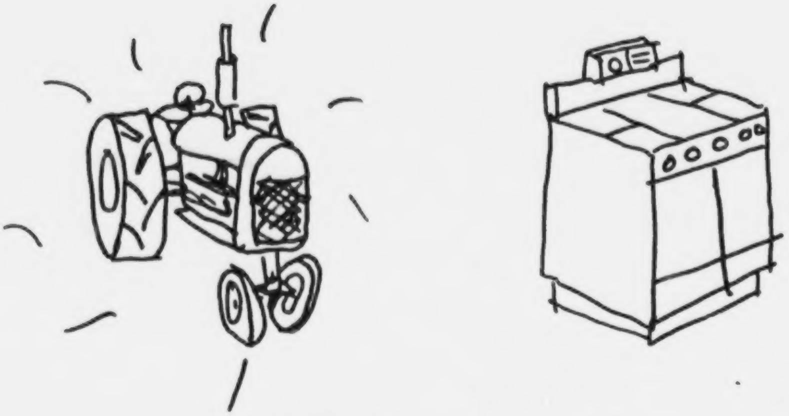
PURE RESEARCH

Exploring nature to seek knowledge

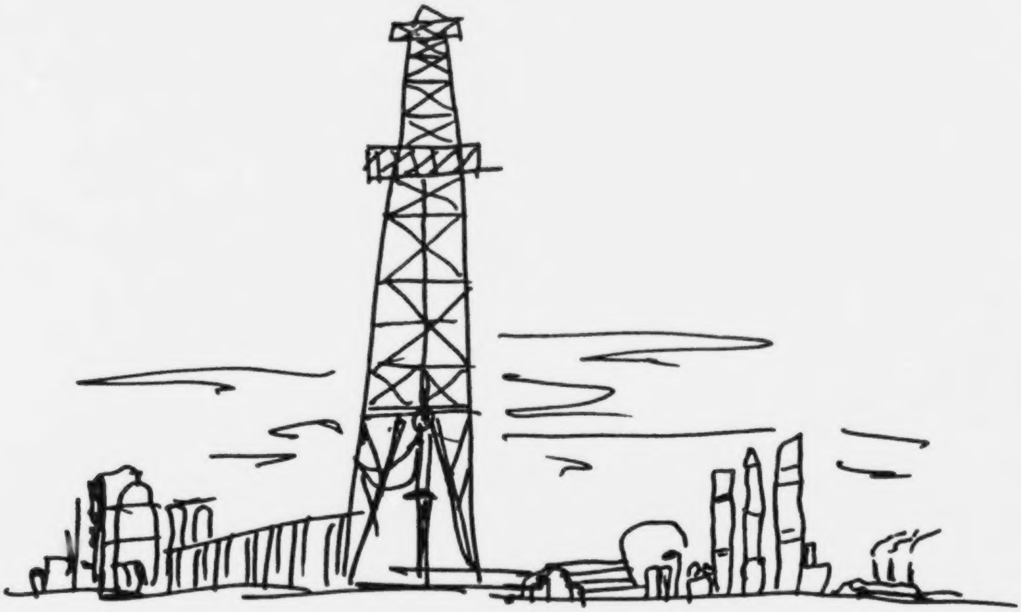
APPLIED RESEARCH

Solving specific problems facing a company

Functions of Development

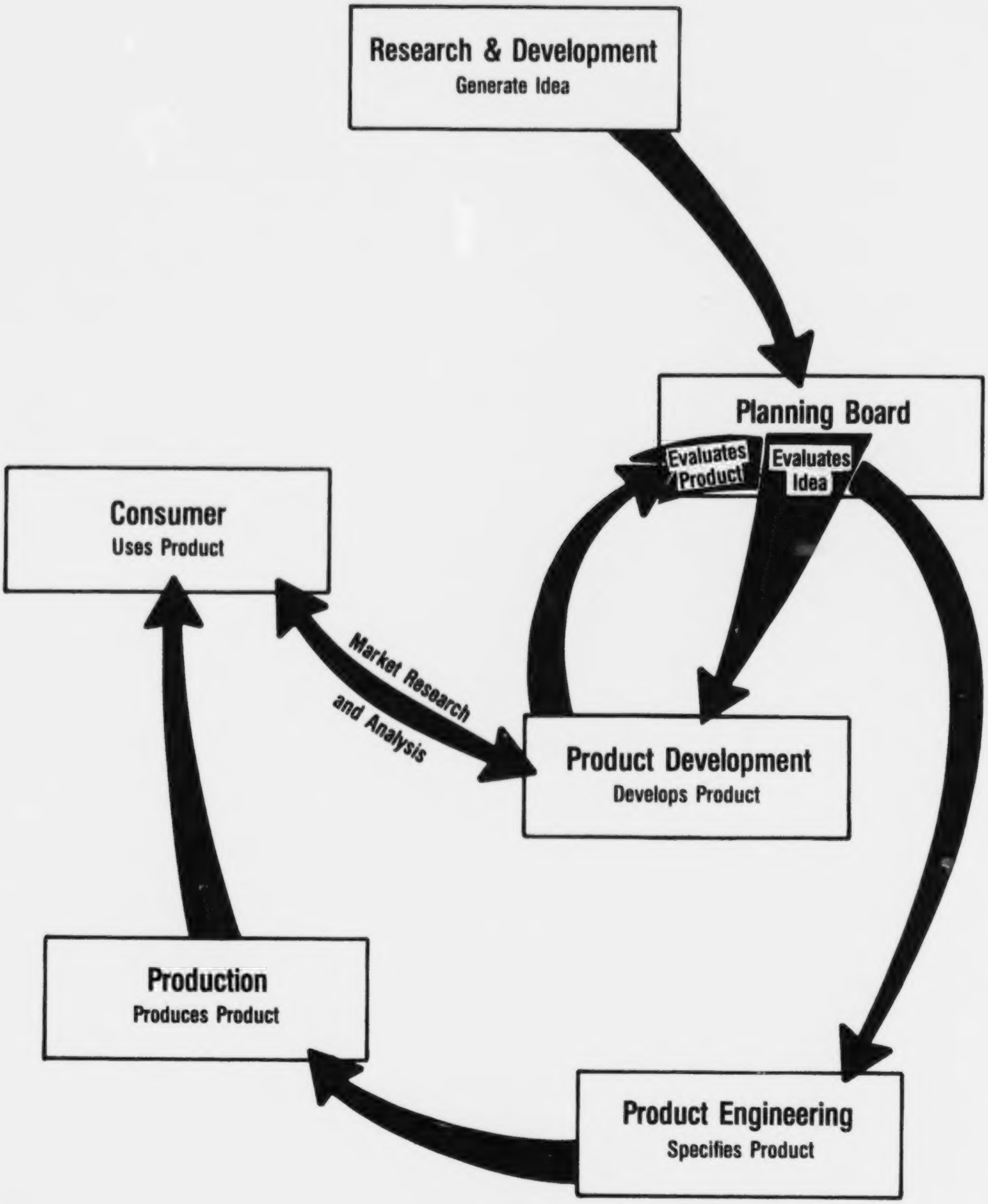


Designing new and improved products



Designing new and improved systems, operations, and processes

Product Development Cycle



Research & Development
Generate Idea

Planning Board
Evaluates Product
Evaluates Idea

Consumer
Uses Product

Market Research and Analysis

Product Development
Develops Product

Production
Produces Product

Product Engineering
Specifies Product

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #1 — SAMPLE PRODUCT PROFILE (FOR TTT GAME)

Market Considerations

Who is the market? People -- age 8-17

How big is the market? 130 units will be sold

Is there competition? Product must not compete with major toy manufacturers

Product Considerations

What is the product? Game or recreational

How can product be used? Entertain children in car or home

What is the product's life expectancy? 3-8 yrs.

Production Considerations

How difficult will product be to manufacture? low number of parts, simple in design and construction

What equipment is needed? Basic wood working machines and hand tools

What materials are needed? Wood for majority of product, some plastic or metal if needed.

How much time and money must be allowed for tooling and set-up? 4 days, $\$15^{00}$

Financial Considerations

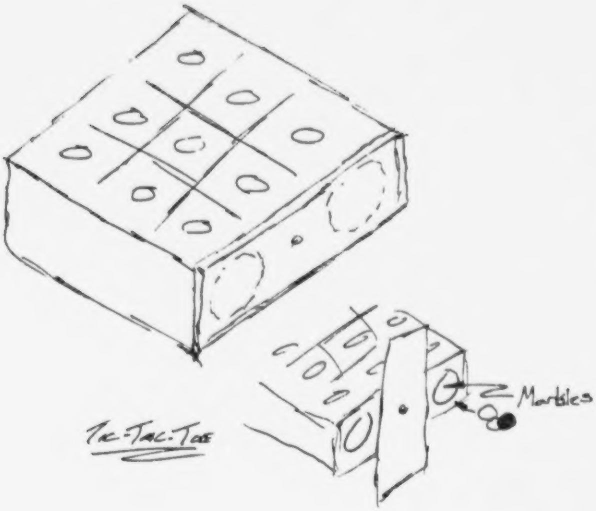
How much will manufacturing cost? $\$1^{50}$ materials plus overhead

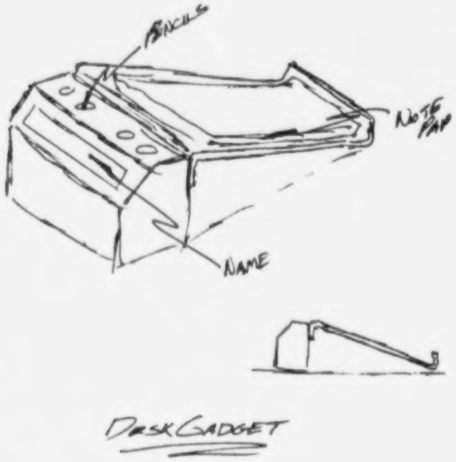
What is the selling price? $3.00 to 4.00

What is the profit margin? $\$1^{50}$ to 2^{50} per product

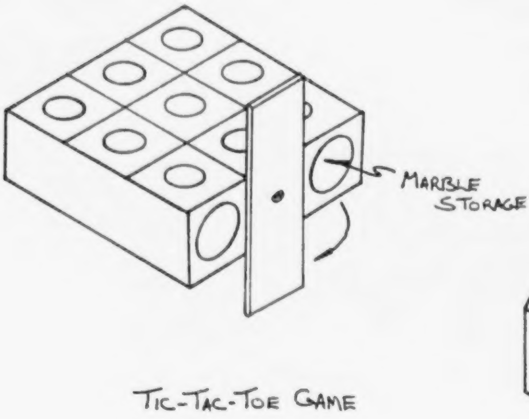
IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

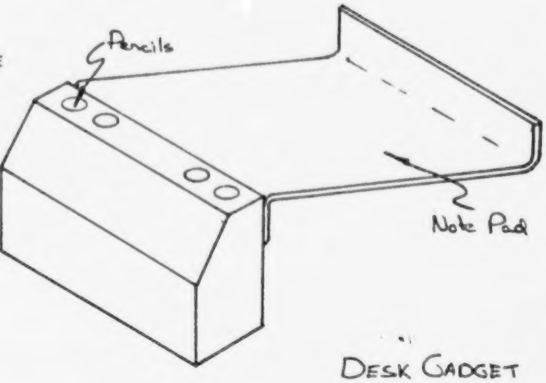
HANDOUT #2 — SAMPLE SKETCHES


Marbles
Tic-Tac-Toe


Pencils
Note Pad
Name
Desk Gadget

Rough Sketches

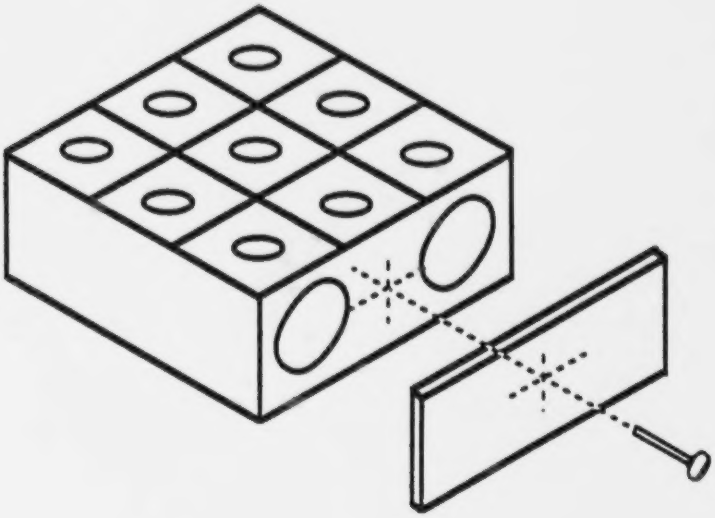

Marble Storage
Tic-Tac-Toe Game


Pencils
Note Pad
Desk Gadget

Refined Sketches

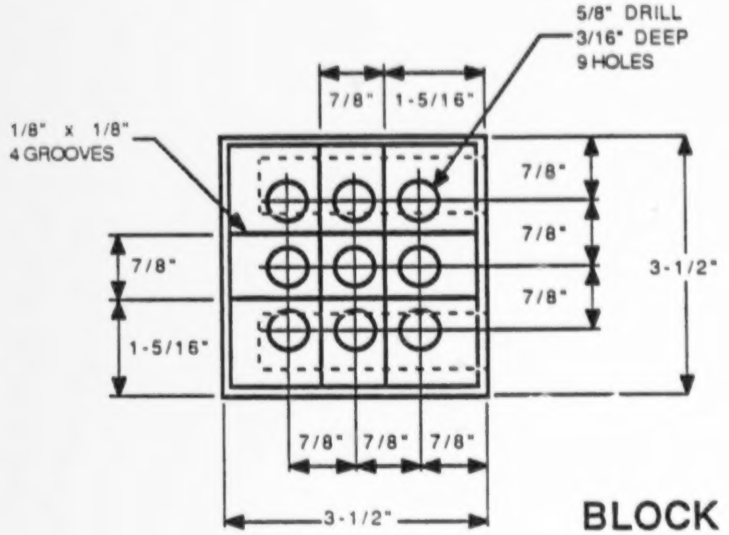
IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #3 — SAMPLE ASSEMBLY DRAWING

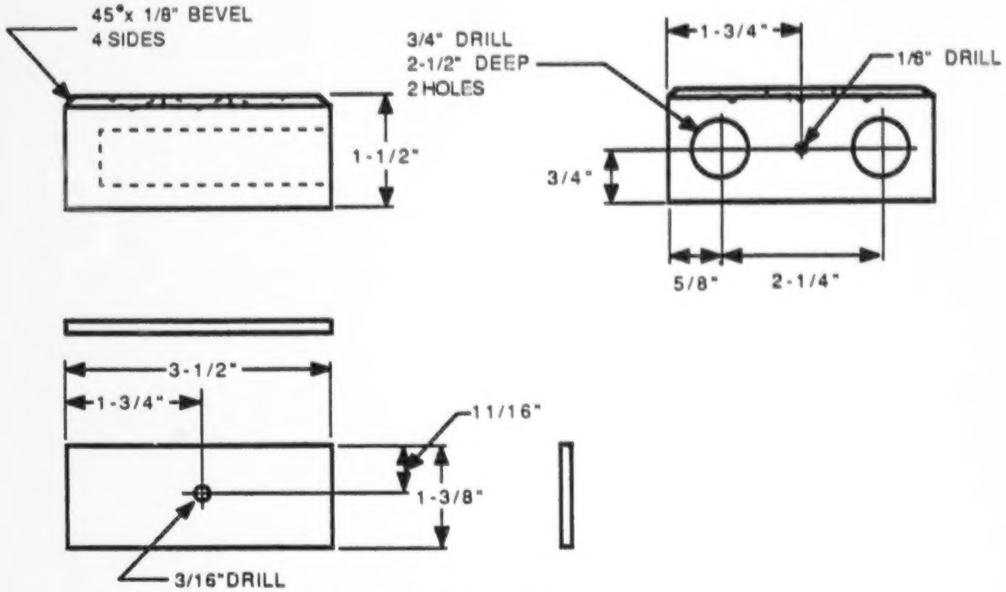


IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #4 — SAMPLE DETAIL DRAWINGS


5/8" DRILL
3/16" DEEP
9 HOLES
7/8"
1-5/16"
1/8" x 1/8"
4 GROOVES
7/8"
7/8"
7/8"
3-1/2"
7/8"
1-5/16"
7/8"
7/8"
7/8"
3-1/2"

BLOCK DETAIL


45°x 1/8" BEVEL
4 SIDES
1-1/2"
3/4" DRILL
2-1/2" DEEP
2 HOLES
1-3/4"
1/8" DRILL
3/4"
5/8"
2-1/4"
3-1/2"
1-3/4"
11/16"
1-3/8"
3/16"DRILL

SLIDE DETAIL

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #5 — SAMPLE MARKET SURVEY

Please assist us in determining the marketability of this product by completing the following survey. Your cooperation in this matter is appreciated. Please circle your answers and fill in appropriate responses. Thank you.

Product **Tic-Tac-Toe**

Personal Information

1) Age:
   - 11 or under
   - [✓ 16-20]
   - 12-15
   - Over 20

2) Sex:
   - [✓ Male]
   - Female

3) Level of education completed:
   - Elementary
   - [✓ Sr. High]
   - Middle/Jr. High
   - College

4) Residence:
   - [✓ House]
   - Apartment

Market Information

1) Would you buy a product like this?
   - [✓ Yes]
   - No

2) What do you think the selling price should be?
   - Under $1.00
   - $3.00-4.00
   - $1.00-2.00
   - $4.00-5.00
   - [✓ $2.00-3.00]
   - Over $5.00

Product Information

1) Do you think this product should be changed in any way?
   - [✓ Yes]
   - No

2) What changes would make this a better product? Decorate some

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #6 — SAMPLE MARKET SURVEY SUMMARY FORM

Product Tic-Tac-Toe

Total Number Surveyed 100

Personal Information

1) Age
11 or Under 21
12 to 15 49
16 to 20 20
Over 20 10

2) Sex
Male 57
Female 43

3) Education
Elementary 21
Middle/Jr. High 49
Sr. High 25
College 5

4) Residence
House 80
Apartment 20

Market Information

1) Would you buy a product like this?
Yes 70
No 30

2) Selling price
Under 1.00 2
1.00-2.00 4
2.00-3.00 11
3.00-4.00 49
4.00-5.00 31
Over 5.00 3

Product Information

1) Do you think this product should be changed in any way?
Yes 21
No 79

2) Product changes.
More decorative, different color

Based on the data recorded on the Market Survey Summary Form, what decisions would you make concerning the product?

1) Should the product be produced? • [✓ Yes] • No
If yes, how many should be produced? 100 - 200

2) Should changes be made in the product before it is produced? • Yes • [✓ No]
If yes, what change(s) should be made?

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

HANDOUT #7 — SAMPLE BILL OF MATERIALS

Product Name Tic -Tac -Toe

Part No.	Part Name	No. of Parts Needed per Product	Size			Material
			T ×	W ×	L	
1	Block	1	1 1/2	3 1/2"	3 1/2"	Pine
2	Slide	1	1/8"	1 1/2	3 1/2"	Pine
S1	Screw	1	No. 8		1/2"	Brass
M1	Marbles	2 sets	5/8 Dia.			Glass

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

ASSIGNMENT SHEET #1 — DESIGN A PRODUCT THAT CAN BE MASS PRODUCED BY YOUR CLASS

NAME ______________________ SCORE ____________________

Directions: You will be assigned to work in groups of threes and your task is to design a product which may be mass produced by your class. All products must be made of material readily available to the class, and must be able to be built in the classes' laboratory. Design one of the following:

A. A desktop accessory which could fit in a box 6" wide × 6" deep × 12" long.

B. A game that would fit in a box 10" wide × 10" deep × 10" long.

C. A toy vehicle that would fit in a box 4" wide × 4" deep × 8" long.

D. Other, as specified by your teacher.

Upon completion, your group will present your refined sketches and appearance model to the rest of the class. One or more will be selected for further development.

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

ASSIGNMENT SHEET #2 — COMPLETE A PRODUCT PROFILE FOR THE PROTOTYPE

NAME ____________________ SCORE ____________________

Directions: Complete the following product profile for the class prototype.

Market Considerations

Who is the market? ____________________

How big is the market? ____________________

Is there competition? ____________________

____

Product Considerations

What is the product? ____________________

How can product be used? ____________________

What is the product's life expectancy? ____________________

Production Considerations

How difficult will product be to manufacture? ____________________

What equipment is needed? ____________________

____

What materials are needed? ____________________

____

How much time and money must be allowed for tooling and set-up? ____________________

____

Financial Considerations

How much will manufacturing cost? ____________________

What is the selling price? ____________________

What is the profit margin? ____________________

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

ASSIGNMENT SHEET #3 — CONDUCT A MARKET SURVEY FOR THE PROTOTYPE

NAME ____________________________ SCORE ______________________

Directions: 1) Look at and study the prototype your class has developed (or an actual product assigned by your instructor).

2) Record your opinions and requested information on the Market Survey Form provided.

3) Interview at least one other person outside of your class and get their opinion.

4) Record the information on another Market Survey Form.

5) Compile the results of all the Market Survey Forms on the Market Survey Summary Form. Then make decisions about producing the product from the recorded data.

MARKET SURVEY

Please assist us in determining the marketability of this product by completing the following survey. Your cooperation in this matter is appreciated. Please circle your answers and fill in appropriate responses. Thank you.

Product ____________________________

Personal Information

1) Age:
   - 11 or under
   - 12-15
   - 16-20
   - Over 20

2) Sex:
   - Male
   - Female

3) Level of education completed:
   - Elementary
   - Middle/Jr. High
   - Sr. High
   - College

4) Residence:
   - House
   - Apartment

Market Information

1) Would you buy a product like this?
   - Yes
   - No

2) What do you think the selling price should be?
   - Under $1.00
   - $1.00-2.00
   - $2.00-3.00
   - $3.00-4.00
   - $4.00-5.00
   - Over $5.00

Product Information

1) Do you think this product should be changed in any way?
   - Yes
   - No

2) What changes would make this a better product? ____________________________

____

____

ASSIGNMENT SHEET #3

MARKET SURVEY

Please assist us in determining the marketability of this product by completing the following survey. Your cooperation in this matter is appreciated. Please circle your answers and fill in appropriate responses. Thank you.

Product ____________________________

Personal Information

1) Age:
   - 11 or under
   - 12-15
   - 16-20
   - Over 20

2) Sex:
   - Male
   - Female

3) Level of education completed:
   - Elementary
   - Middle/Jr. High
   - Sr. High
   - College

4) Residence:
   - House
   - Apartment

Market Information

1) Would you buy a product like this?
   - Yes
   - No

2) What do you think the selling price should be?
   - Under $1.00
   - $1.00-2.00
   - $2.00-3.00
   - $3.00-4.00
   - $4.00-5.00
   - Over $5.00

Product Information

1) Do you think this product should be changed in any way?
   - Yes
   - No

2) What changes would make this a better product? ________________________

ASSIGNMENT SHEET #3

MARKET SURVEY SUMMARY FORM

Product ______________________ Total Number Surveyed __________

Personal Information

1) Age
11 or Under ______
12 to 15 ______
16 to 20 ______
Over 20 ______

2) Sex
Male ______
Female ______

3) Education
Elementary ______
Middle/Jr. High ______
Sr. High ______
College ______

4) Residence
House ______
Apartment ______

Market Information

1) Would you buy a product like this?
Yes ______
No ______

2) Selling price
Under 1.00 ______
1.00-2.00 ______
2.00-3.00 ______
3.00-4.00 ______
4.00-5.00 ______
Over 5.00 ______

Product Information

1) Do you think this product should be changed in any way?
Yes______
No______

2) Product changes.
____
____
____
____
____

Based on the data recorded on the Market Survey Summary Form, what decisions would you make concerning the product?

1) Should the product be produced? • Yes • No

If yes, how many should be produced? __________

2) Should changes be made in the product before it is produced? • Yes • No

If yes, what change(s) should be made? ______________________________

____

____

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

ASSIGNMENT SHEET #4 — COMPLETE A BILL OF MATERIALS FOR THE PROTOTYPE

NAME ____________________________ SCORE ______________________

Directions: Complete a bill of materials for the class prototype.

Product Name ____________________________

Part No.	Part Name	No. of Parts Needed per Product	Size			Material
			T ×	W ×	L	

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

TEST

NAME ______________________________ SCORE ______________________

1. Match the terms on the right with the correct definitions.

_____a. Developing and refining ideas leading to new or improved products, processes, and materials

_____b. Assorted pieces of information, later sorted and organized into more complete pictures

_____c. Determines who and where the customer is, needs, will buy, and how much

_____d. A process where many ideas are sketched on paper, with the best ones being selected

_____e. Working model that shows a full-sized working product of the same material that the final product will use

_____f. An appearance model, normally made of cardboard, paper, plaster, clay, or other easy to work with products

1. Ideation
2. Thumbnail sketches
3. Market research
4. Research and development
5. Prototype
6. Models
7. Product profile
8. Mock-up

2. Differentiate between the major functions of research and development by placing the following letters next to the correct descriptions:

R — Research
D — Development
P — Product Development

_____a. Scientifically seeking and discovering knowledge

_____b. Testing product designs and planning for production

_____c. Applying knowledge gained from research to develop new and improved products and processes

TEST

3. Distinguish between the two types of research by placing a "P" next to the description of pure research and an "A" next to applied research.

   _____a. Solving specific problems facing a company, usually having direct commercial applications

   _____b. Exploring nature to seek knowledge or information without consideration of commercial application

4. Complete the following statements concerning the two processes of research and development by circling the best answers.

   a. (**Laboratory testing, Collection of data**) is information gathered during the research process.

   b. (**Laboratory testing, Collection of data**) is when techniques and procedures are evaluated and experimented with in a laboratory situation.

5. Select from the following list the main types of professionals involved in research and development.

   _____a. Scientists

   _____b. Lawyers

   _____c. Surgeons

   _____d. Clergy

   _____e. Engineers

   _____f. Teachers

6. Select from the following list the two correct functions of development.

   _____a. Looks for knowledge without commercial considerations

   _____b. Looks for economical applications of the results of research

   _____c. Concerned with designing new and improved products and processes

   _____d. Involved in sales and distribution of products

7. Complete the following statements concerning product development by circling the best answers.

   a. Creates and tests product (**designs, models**).

   b. Is a subdivision of (**research, development**).

   c. Tries to develop products that meet or beat the competition and that are wanted by (**customers, management**).

TEST

8. Complete statements concerning the two approaches to developing new products by circling the best answers.

   a. The (**production, consumer**) approach develops innovative new products first and then convinces consumers they need them.

   b. The (**production, consumer**) approach determines the needs of the consumer first and then develops products to meet them.

9. Complete the following statements concerning sources of product ideas by circling the best answers.

   a. Market research used to determine consumers' wants and needs is an example of (**product, consumer**) research.

   b. New materials resulting from technological advancements (**are, are not**) a source of new products.

   c. Companies getting their ideas from competitors are examples of (**stealing, competitive awareness**).

10. Select from the following list the three major factors considered in designing a product by placing an "X" in the appropriate blanks.

______a. Size

______b. Function

______c. Marketability

______d. Engineering

______e. Ability to be manufactured

______f. Serviceability

11. Select from the following list the main elements in a product profile by placing an "X" in the appropriate blanks.

______a. Product considerations

______b. Financial considerations

______c. Research considerations

______d. Preliminary considerations

______e. Market considerations

______f. Production considerations

TEST

12. Arrange in order the steps in product development by placing the correct sequence numbers (1-7) in the appropriate blanks.

______a. Detailed sketches are made (engineering drawings).

______b. Market is tested.

______c. Prototypes are built.

______d. Preliminary designs are developed (thumbnail and rough sketches).

______e. Mock-ups are made.

______f. Product is tested.

______g. Refined sketches are made.

13. Complete the following statements concerning market research and development by circling the best answers.

a. Market research is the collecting, recording, and analyzing of facts related to the (**sale, development**) of products.

b. Market surveys are used to gather data concerning (**consumers, competition**).

14. Complete the following statements concerning process development by circling the best answers.

a. The process development group is responsible for planning systems or processes which (**sell, produce**) the product.

b. A question that process development is concerned with before a product is produced is (**What equipment is needed for production?, How will we distribute this product?**)

15. Select the correct definition and purpose of product engineering by placing an "X" next to the correct answer.

______a. Collecting information during the research process to discover new information

______b. Creating and testing possible design ideas for potential products

______c. Final refinement of product designs, through the use of specifications, standards, and testing, to make it ready for manufacturing

TEST

16. Complete the following statements concerning the areas of product engineering by circling the correct answers.

    a. Product design specification is concerned with engineering (**drawings, testing**).

    b. Engineering testing checks a product in regard to service and repair, tests and gathers information about performance of the product under actual work conditions, and (**completes bill of materials, evaluates quality and final appearance**).

    c. Product engineers that provide advice and information to production personnel in regard to manufacturing problems are known as (**analysts, consultants**).

17. Select from the following list the criteria that guide product selection by placing an "X" next to the correct criteria.

    _____a. Cost limitations

    _____b. Time limitations

    _____c. Detail drawings

    _____d. Mass production

    _____e. Production facility limitations

    _____f. Market or consumer needs

    _____g. Consultations

    _____h. Skill of labor force

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

18. Design a product that can be mass produced by your class. (Assignment Sheet #1)

19. Complete a product profile for the prototype. (Assignment Sheet #2)

20. Conduct a market survey for the prototype. (Assignment Sheet #3)

21. Complete a bill of materials for the prototype. (Assignment Sheet #4)

IDENTIFYING AND DESIGNING A PRODUCT
UNIT V

ANSWERS TO TEST

1.
   a. 4
   b. 2
   c. 3
   d. 1
   e. 5
   f. 8

2.
   a. R
   b. P
   c. D

3.
   a. A
   b. P

4.
   a. Collection of data
   b. Laboratory testing

5. a, e

6. b, c

7.
   a. Designs
   b. Development
   c. Customers

8.
   a. Production
   b. Consumer

9.
   a. Consumer
   b. Are
   c. Competitive awareness

10. b, c, e

11. a, b, e, f

ANSWERS TO TEST

12. a. 4
    b. 7
    c. 5
    d. 1
    e. 3
    f. 6
    g. 2

13. a. Sale
    b. Consumers

14. a. Produce
    b. What equipment is needed for production?

15. c

16. a. Drawings
    b. Evaluate quality and final appearance
    c. Consultants

17. a, b, e, f

18.-21. Evaluated to the satisfaction of the instructor

PRODUCT MANUFACTURING
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the various stages in product manufacturing and list factors that must be considered when deciding how a product should be manufactured. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to product manufacturing with the correct definitions.
2. Select from a list factors that determine how a manufacturing enterprise is organized.
3. Select from a list the two types of manufacturing production methods.
4. Distinguish between the two common types of mass production.
5. Select from a list the key principles of mass production.
6. Complete statements concerning the components needed for production.
7. Complete statements concerning the responsibilities of industrial engineering.
8. Match methods for selection and sequence of manufacturing operations (and their components) with their correct descriptions and examples.
9. Select from a list considerations in tooling up.
10. Select from a list the major objectives of tooling.

OBJECTIVE SHEET

11. Match the types of tooling required for interchangeability of parts with their descriptions and examples.
12. Select from a list the considerations in plant layout.
13. Distinguish between the two basic types of plant layout.
14. Select from a list the characteristics of a good material-handling system.
15. Distinguish between the two types of material-handling equipment.
16. Match actions monitored by production planning and control with the correct descriptions.
17. Select from a list the major functions of quality control.
18. Select from a list the steps involved in inspection.
19. Arrange in order the steps in obtaining materials and equipment for production.
20. Complete statements concerning the steps in obtaining labor for production.
21. Select from a list the attributes an employer looks for in an employee.
22. Select from a list the contents of a labor contract.
23. Complete a flow process chart. (Assignment Sheet #1)
24. Develop an operation process chart. (Assignment Sheet #2)
25. Complete an operation analysis sheet. (Assignment Sheet #3)
26. Design a jig or fixture. (Assignment Sheet #4)
27. Make a plant layout and develop a flow diagram. (Assignment Sheet #5)
28. Design an inspection gage. (Assignment Sheet #6)
29. Complete a job description. (Assignment Sheet #7)
30. Complete a job application form. (Assignment Sheet #8)

PRODUCT MANUFACTURING
UNIT VI

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Provide students with objective sheet.

C. Discuss unit and specific objectives.

D. Provide students with information and assignment sheets.

E. Discuss information and assignment sheets.

F. Integrate the following activities throughout the teaching of this unit:

1. Have student do role playing activities such as labor problems, negotiating a contract, and interviewing for a job.
2. Demonstrate to students how to design a plant layout using a floor plan and scale outlines of machinery.
3. Make a safety inspection of the school laboratory.
4. Discuss problems in materials handling.
5. Select methods of materials handling in the laboratory. Design and build conveyor systems, slides, etc.
6. Develop a time schedule for departments in the mass production activity including information about each activity and individual responsible.
7. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

G. Give test.

H. Evaluate test.

I. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

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B. Fales, James, et. al. *Manufacturing: A Basic Text*, 2nd ed. Encino, CA: Glencoe Publishing Co., 1986.

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I. Wright, R. Thomas and Richard M. Henak. *Exploring Production*. South Holland, IL: Goodheart-Willcox Co., 1985.

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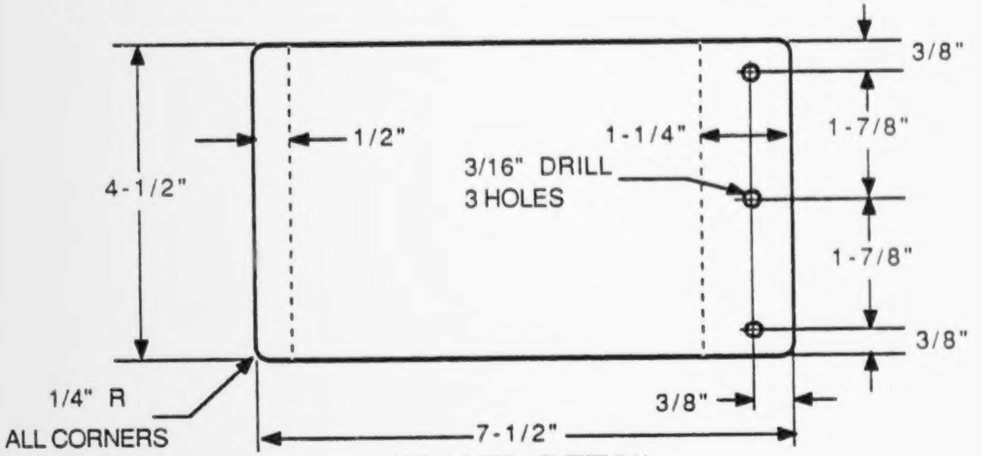
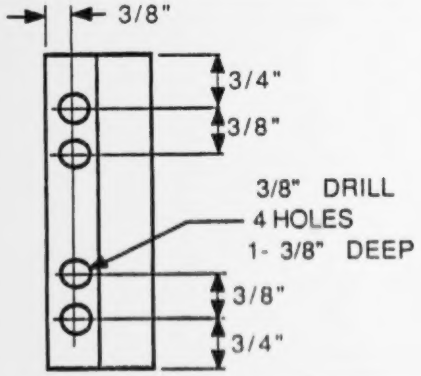
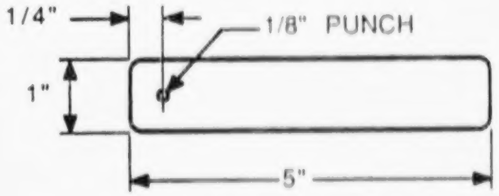
PRODUCT MANUFACTURING
UNIT VI

TEACHER SUPPLEMENT #1 — DESK GADGET DETAIL DRAWINGS


3/8"
1-7/8"
1-1/4"
1/2"
3/16" DRILL
3 HOLES
4-1/2"
1-7/8"
3/8"
1/4" R
ALL CORNERS
3/8"
7-1/2"

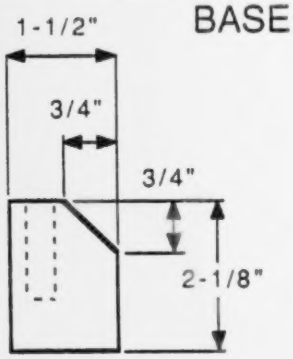
FRAME DETAIL

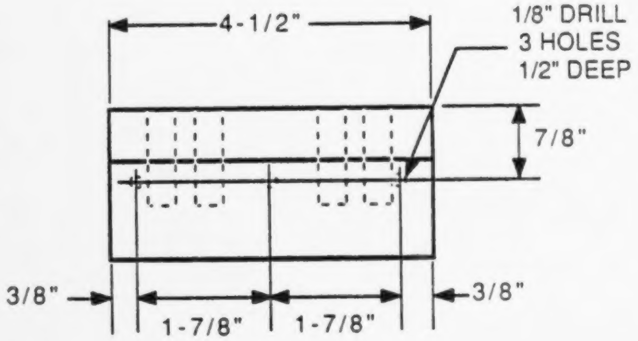

3/8"
3/4"
3/8"
3/8" DRILL
4 HOLES
1- 3/8" DEEP
3/8"
3/4"


1/4"
1/8" PUNCH
1"
5"

CLIP DETAIL

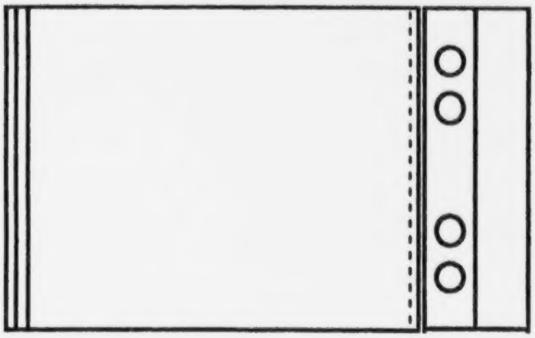
BASE DETAIL

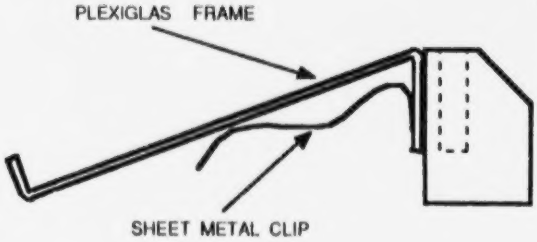

1-1/2"
3/4"
3/4"
2-1/8"

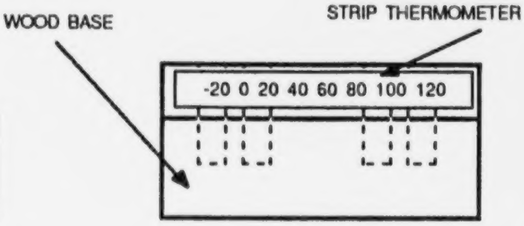

4-1/2"
1/8" DRILL
3 HOLES
1/2" DEEP
7/8"
3/8"
1-7/8"
1-7/8"
3/8"

PRODUCT MANUFACTURING
UNIT VI

TEACHER SUPPLEMENT #2 — DESK GADGET ASSEMBLY DRAWING



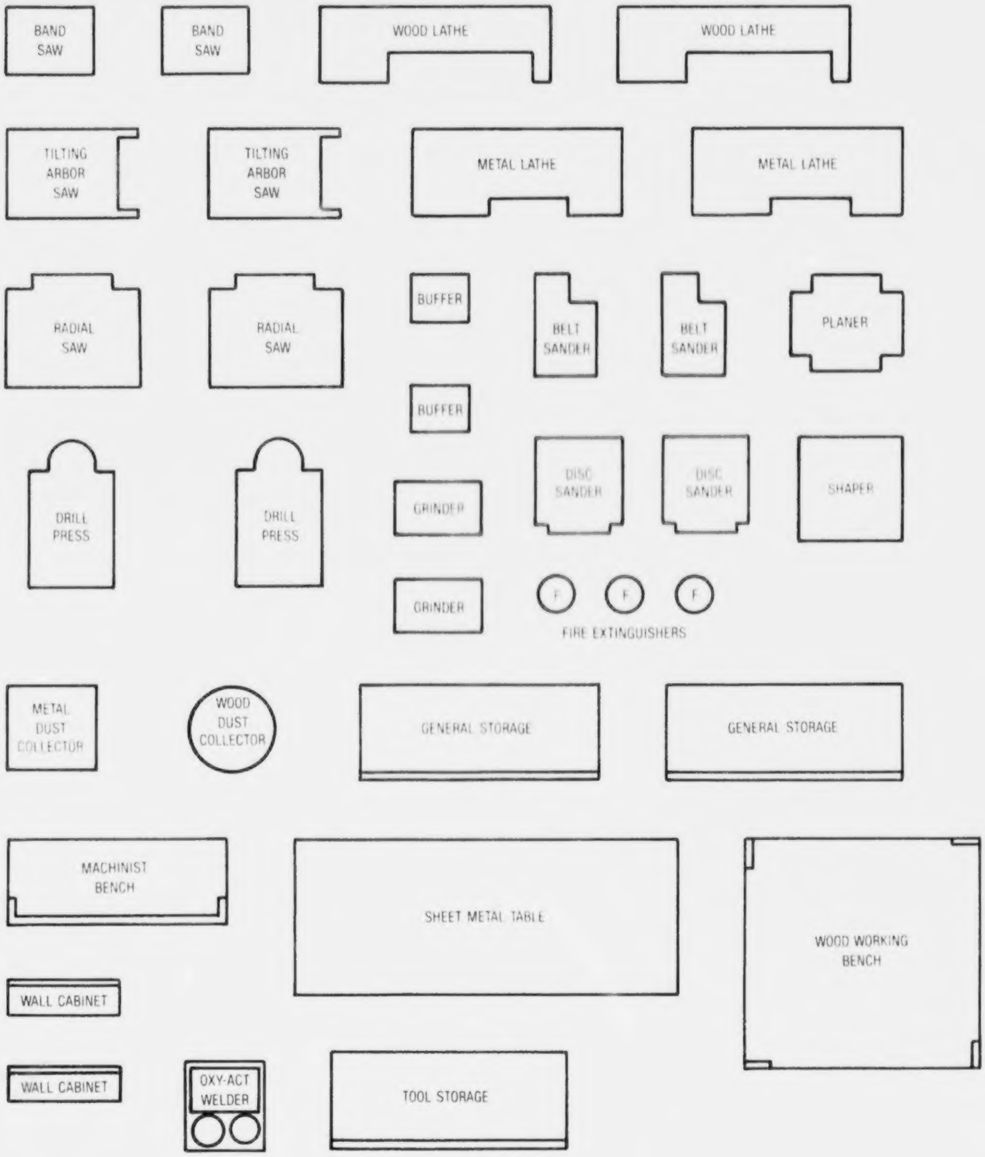

PLEXIGLAS FRAME
SHEET METAL CLIP


WOOD BASE
STRIP THERMOMETER
-20 0 20 40 60 80 100 120

PRODUCT MANUFACTURING
UNIT VI

TEACHER SUPPLEMENT #3 — MACHINE OUTLINES (TEMPLATES)

(NOTE: Make copies of these outlines for students to use in Assignment Sheet #5.)


BAND SAW
BAND SAW
WOOD LATHE
WOOD LATHE
TILTING ARBOR SAW
TILTING ARBOR SAW
METAL LATHE
METAL LATHE
RADIAL SAW
RADIAL SAW
BUFFER
BELT SANDER
BELT SANDER
PLANER
BUFFER
DRILL PRESS
DRILL PRESS
GRINDER
DISC SANDER
DISC SANDER
SHAPER
GRINDER
F
F
F
FIRE EXTINGUISHERS
METAL DUST COLLECTOR
WOOD DUST COLLECTOR
GENERAL STORAGE
GENERAL STORAGE
MACHINIST BENCH
SHEET METAL TABLE
WOOD WORKING BENCH
WALL CABINET
WALL CABINET
OXY-ACT WELDER
TOOL STORAGE

Scale: ¼" = 1' (appx.)

PRODUCT MANUFACTURING
UNIT VI

INFORMATION SHEET

I. **Terms and definitions**

A. **Assembly** — Combination of subassemblies and/or components

B. **Automation** — The operation of machines and processing equipment without an operator controlling them; usually control is by a computer

C. **By-product** — Something produced in addition to the main product

D. **Collective bargaining** — Process of negotiating a contract between management and labor

E. **Contract** — An agreement between management and labor

F. **Finished product** — A completed product ready for the consumer

G. **Inspection** — Compares the product against quality standards to see if it meets specifications

Example: A go-no go gage is used to inspect the diameter of a hole.

H. **Machine** — A specific piece of equipment designed to do a specific process

Examples: Drop forge, injection molder, spot welder, drill press

I. **Mechanization** — The equipping of industry with machines for production work

J. **Operation** — Only one of a series of specific actions done to produce a part, the collection of which makes up a job for the worker

Examples: Bend, solder, drill, cut

K. **Process (in "sequence of operation")** — A series of operations usually resulting in some type of change in the structure or appearance of a material and a specific end product

Examples: Forging, injection molding, spot welding

L. **Production** — Activities resulting in the manufacture of a product

M. **Productivity** — The measure of production output per unit of labor for production

INFORMATION SHEET

N. **Robot** — A reprogrammable, multifunctional machine capable of movement and performing a variety of tasks

(NOTE: A robot typically works with other machines in a "workcell".)

O. **Specification** — A written description as to size, quality, etc. of materials for a job

P. **Standard part or component** — A part or component requiring no further processing except assembly

Q. **Standard stock** — Material or stock that requires further processing before it can be used by the consumer

Example: Drill rod, 2 × 4 lumber

R. **Subassembly** — Standard part or components combined to produce sections of a finished product

S. **Tools** (in tooling) — A device used to cut, form, or hold workpiece material; cutting tools in machining; jigs and fixtures in work holding; and punches and dies in metal forming

Examples: Drill bit, drilling jig and fixture, vise, blanking die

T. **Union** — An organization of workers that tries to avoid problems and work out solutions between employees and management

II. Factors that determine how a manufacturing enterprise is organized

A. Quantity desired (at a given time)

B. Quality desired

C. Resources available

III. Two types of manufacturing production methods

A. Custom production — Used to make one-of-a-kind or a very limited number of products. This is the oldest type of manufacturing and typically done by skilled craftsmen. Production is low and cost per item is typically high.

B. Mass production — Produces products by making standardized or interchangeable parts and dividing the labor among many people.

INFORMATION SHEET

IV. **Common types of mass production**

(NOTE: After careful consideration of the factors, companies will pick one or a combination of the following types of manufacturing systems and arrange the production activities accordingly.)

A. Continuous manufacturing

1. Products move down the line at a continuous speed and predetermined rate.
2. Used when large quantities of a product are needed.
3. Product flow does not stop at any time.
4. Utilizes automation and mechanization to reduce labor needs and operations.

   Example: Extrusion line for one size of pipe

B. Intermittent manufacturing

1. Products are manufactured in lots or groups.
2. Used when volume of product needed is too low for continuous manufacturing.
3. Intermittent manufacturing in primary processings is called "batch processing," while in secondary processing it is called "job-lot manufacturing."
4. Companies involved in this type of manufacturing are often called "job shops" since they contract or take orders for specific jobs or quantities.

V. **Key principles of mass production**

A. Parts are duplicated accurately to make interchangeability possible.

(NOTE: This requires precise set ups, measurement, and quality control.)

B. Each worker does a specific job.

C. Tools, equipment, and workers are placed in the order (sequence) operations needed to be done.

D. Wasted time and motion are eliminated.

1. Parts and assembly are brought to and from workers by conveyors or other material-handling devices.
2. Distances that parts and subassemblies travel are kept as short as possible.

INFORMATION SHEET

VI. **Components needed for production**

A. Industrial (manufacturing) engineering — Individuals who deal with the actual production of the product, and develop the methods, facility, and means to produce it.

B. Production planning and control — Individuals responsible for the right materials, in the right amount, at the right time. Involved with routing, loading, scheduling, dispatching, expediting, and monitoring.

C. Quality control — Those activities designed to keep defective items from being produced; if produced, keep them from reaching the market.

D. Material and employees — The substances from which products are manufactured and the workforce to produce the products.

VII. **Responsibilities of industrial engineering**

A. Selection and sequence of manufacturing operations

B. Tooling — Refers to jigs and fixtures, patterns and templates, and tools which are used in production, whether manually operated or operated by numerical control, computer, or robot.

C. Plant layout — Planning the use of all floor space for all operations in a manufacturing facility. Must provide both for the smooth flow of parts and products throughout the plant as well as for the flow of people who work in the plant.

D. Material handling — Provides for the movement of the materials within a manufacturing plant

E. Improvement of manufacturing system

1. Finding a better way by analyzing the system

2. Time and motion studies; work measurement or time study

VIII. **Methods for selection and sequence of manufacturing operations** (Handouts #1-#5)

A. Flow process chart (Handouts #1-#3 and Assignment Sheet #1)

1. Is a chart that shows sequence (step-by-step arrangement) of tasks. Includes operations, transportation, inspections, delays, and storages necessary for producing a single part. It does not show entire manufacturing process of the product, only one part.

INFORMATION SHEET

2. Uses symbols to simplify the chart.

Symbol	Name	Description
○	Operation	Object is modified or changed in its physical or chemical make-up; may be assembled (put together) or disassembled (taken apart)
⇨	Transportation	Object is moved from one location to another
□	Inspection	Object is checked for quality and accuracy
D	Delay	Object waits for its next operation; held until ready
▽	Storage	Object is put in a protected location

3. Provides description of tasks (by marking of symbol), code number for each task, identification of machines required, and identification of tooling required.

B. Operation process chart (Handout #4 and Assignment Sheet #2)

1. Is a chart which shows **all** the operations in the order in which the product is manufactured.

2. Shows sequence of all operations for each part made, how the parts are assembled, and where operations and inspections take place in the manufacturing sequence.

3. Does *not* usually show transportation, delay, and storage tasks.

4. Provides an overview of the entire manufacturing process of the product which can be analyzed by the manufacturing engineer.

INFORMATION SHEET

C. Operation analysis sheet (Handout #5 and Assignment Sheet #3)

1. Is a sheet that lists the steps and operations necessary to manufacture a specific product.

2. Provides the name of operation, machine to be used, and tooling needed.

No.	Name of Operation	Machine	Tooling
1	Drill ¼"	Drill Press	Jig #1; ¼" bit

D. Product flow diagram

1. Is a diagram showing the flow of component parts or objects being produced as they move from one work station to another.

2. Is drawn on a floor plan of the manufacturing plant. (Sometimes called a "route sheet.")

3. Helps provide a pictorial view of the entire manufacturing process and a view of potential bottlenecks or material-handling problems.

E. Material flow diagram

1. Shows movement of *material* from one operation to another.

2. This movement is drawn on the plant layout floor plan.

3. Shows graphic illustration of material flow and possible bottlenecks.

(NOTE: Once the production procedure or specific operations are identified, tooling can begin.)

IX. **Considerations in tooling up** (Assignment Sheet #4)

A. What tools are needed to make the product?

B. What tools need to be purchased?

C. What tools need to be made by or for the company?

X. **Three major objectives of tooling**

A. Accuracy — To provide uniform parts

B. Speed — Proper positioning or locating of parts speeds up production

C. Safety — To provide safer working conditions for employees

(NOTE: Operators do not have to hold or locate pieces by hand because pieces are adequately held in position during an operation. Machine work areas are also equipped with proper safety devices.)

INFORMATION SHEET

XI. **Tooling required for interchangeability of parts**

A. Jigs and fixtures — Used with machines to hold and locate the workpiece during an operation.

  1. Jigs — Hold the workpiece and guide or locate the tool for a cutting or drilling operation.

  2. Fixtures — Only hold and support the workpiece.

B. Patterns and templates — Used to reproduce shapes.

  1. Patterns — Three-dimensional models or forms from which parts are reproduced.

     Example: Pattern used to form mold cavity in sand casting

  2. Templates — Give only the outline of a part; used to aid in layout and trimming of a part.

C. Dies and molds — Used to control the forming or shaping of materials.

D. Cutting dies, special punches, and other special tools — Used to trim materials to proper size and to generate irregular holes or shapes of the correct size and shape.

E. Gages (gauges) — Used for checking the dimensional accuracy of parts; inspection and quality control devices.

XII. **Considerations in plant layout** (Handout #6 and Assignment Sheet #5)

(NOTE: The manufacturing engineer must consider the following in planning a **safe**, **efficient**, and **productive** plant.)

A. Location of machines

B. Movement of material

C. Location of aisles for movement of people and material

D. Location of utilities for hookups of electricity, water, gas, air, etc.

(NOTE: **Safety** and **productivity** are the underlying considerations in all of these.)

INFORMATION SHEET

XIII. Two basic types of plant layout

A. Process layout

1. Machines are grouped according to the process they perform.

   Example: All cutting in one area, all finishing in another.

2. Departments are formed in this type of layout.

   Example: Assembly, inspection, finishing

3. Used for custom and some intermittent manufacturing

B. Product layout

1. Machines and work stations are arranged according to sequence of operations.

   Example: Machine for second operation is next to first machine, etc.

2. Used to manufacture a large number of a few products

3. Generally used for continuous manufacturing

XIV. Characteristics of a good material-handling system

A. Minimizes how often and how far materials are handled

(NOTE: Efficient systems can reduce a product's cost.)

B. Uses mechanization to move materials whenever possible

Example: Automatic feeding system

XV. Two types of material-handling equipment

A. Fixed path

1. Material moved from one fixed point to another, always on the same path

   Examples: Elevators, pipes, chutes, conveyors, "pick and place" robots

2. Usually associated with continuous manufacturing

INFORMATION SHEET

B. Variable path

  1. Can move material in various directions; can be steered.

     Examples: Hand trucks, fork lifts, overhead cranes, robots which follow buried cables and are directed by a computer

  2. Used in intermittent manufacturing and to load materials in continuous manufacturing

XVI. Actions monitored by production planning and control

A. Routing — Identifies a path the product follows as each operation is performed throughout the plant

B. Loading — Total time it takes to complete the needed operations on a part

   Example: Total drilling time, total assembly time

C. Scheduling — Determines the time and place each operation will be performed, thereby regulating the volume of production

D. Dispatching — Involves issuing production orders to start the work that has been scheduled

E. Expediting — Determines if the work is being completed as planned

F. Monitoring (control) — Checks the product quantity and quality against the production plan. Controlling production uses:

  1. Product output data — Production reports

  2. Quality control data — Inspection reports

  3. Labor utilization (use) data — Labor records

XVII. Major functions of quality control

(NOTE: Quality control is responsible for maintaining the level of quality standards called for in the product specification.)

A. To develop a program that provides for quality to be built into the product

B. To develop an inspection system that checks the part or product against some standard

INFORMATION SHEET

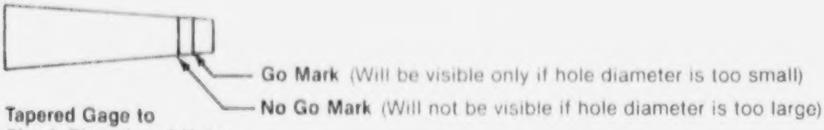
XVIII. Steps involved in inspection

(NOTE: Inspection involves comparing products against quality standards to see if a product meets specifications.)

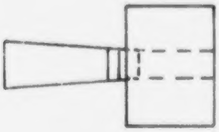
A. Determine appropriate quality standards.

B. Build gages to check parts and products. (Assignment Sheet #6)

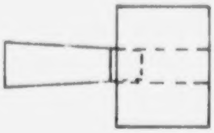
Example: A go-no go gage is used to inspect the diameter of holes.


Go Mark (Will be visible only if hole diameter is too small)
No Go Mark (Will not be visible if hole diameter is too large)

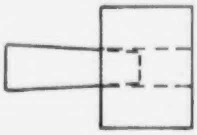
Tapered Gage to Check Diameter of Holes



Hole diameter too small



Hole diameter is "OK"



Hole diameter is too large

C. Develop an inspection program to check parts and products periodically.

D. Before, during, and after manufacturing, identify parts that can be salvaged by reworking.

(NOTE: Now that the production has been planned, it is necessary to obtain materials, equipment, and labor.)

XIX. Steps in obtaining materials and equipment for production (purchasing procedures)

A. Purchase requisition made — A request for materials by a company or department of a company. The form for requisitioning lists the following:

1. Material or equipment needed
2. Quantity needed
3. Delivery date
4. Delivery instructions (location, plant, department)

B. Quotation requests sent out — Form sent to vendors (suppliers) requesting prices (bids or quotes) on materials or equipment needed

INFORMATION SHEET

C. Purchase order issued — Formal contract between vendor and buyer (company) for purchase of materials, tools, services, etc.

(NOTE: Other forms are used if there are changes or mistakes in the order. These include change order forms and discrepant reports.)

D. Shipment and invoice received — The invoice (bill) indicates order has been shipped and money for order is owed.

E. Shipment accepted — Company signs form indicating the supplies received are accepted and payment is authorized.

F. Payment made on order — Money is paid to vendors for the supplies received.

XX. Steps in obtaining labor for production

A. Determine employees needed.

B. Develop job descriptions. (Assignment Sheet #7)

C. Recruit and gather information about job applicants. (Assignment Sheet #8)

1. Have job applications filled out.

2. Interview prospective employees.

3. Test performance skills and/or knowledge of subject. (May not be needed for all jobs)

D. Select employees.

E. Provide training through apprenticeship programs, cooperative education, or on-the-job training.

XXI. Attributes an employer looks for in an employee

A. Enthusiasm and interest

(NOTE: This includes taking pride in your work and being willing to do your share of the work and more when needed.)

B. Dedication and dependability

(NOTE: This involves good work habits which include regular attendance, being on time, and giving 8 hours of work for 8 hours of pay.)

INFORMATION SHEET

C. Alertness, quickness of mind

(NOTE: You should always look for unsafe situations that could injure workers or damage property, and you should constantly look for more efficient working practices.)

D. Honesty and integrity

(NOTE: Employees should give truthful information both to customers and to their employer. They should never steal or allow others to steal the employer's or customer's property.)

E. Desire to work

F. Ability to work with others and to follow orders

G. Desire to improve oneself

(NOTE: Good employees always look for ways to increase their knowledge. This benefits both the employer and employee.)

H. Neat, clean appearance

I. No evidence of drug or alcohol use affecting job performance

J. Decision-making ability

K. Problem-solving ability

L. Competent in necessary skills

XXII. Contents of labor contract

(NOTE: A contract is an agreement between management and labor.)

A. Rights of management

B. Employees affected by contract

C. Wages (including overtime)

D. Working hours

E. Vacations and holidays

F. Employment hiring, promotion, and dismissal procedures

G. Working conditions

H. Grievance procedures — Official complaint by a worker

I. Duration of contract — When it starts and ends

PRODUCT MANUFACTURING
UNIT VI

HANDOUT #1 — FLOW PROCESS CHART

PRODUCT NAME TIC-TAC-TOE

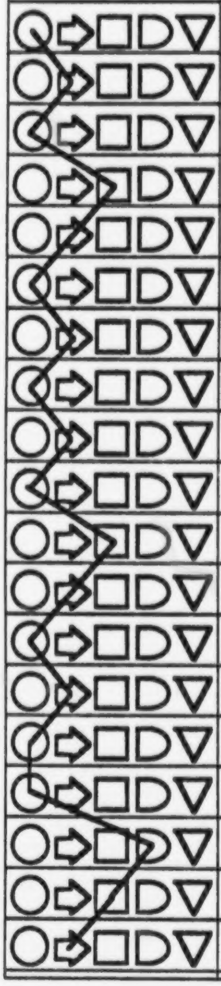
PART NAME BLOCK

PART NUMBER 1 **DATE** __/__/__

CHART BEGINS O-1

CHART ENDS T-8

○ OPERATIONS 8 D DELAYS 1
□ INSPECTIONS 3 ▽ STORAGES 0
⇨ TRANSPORTATIONS 8 TIME ___



Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○ ⇨ □ D ▽	O-1	SURFACE STOCK TO SIZE				PLANER	
○ ⇨ □ D ▽	T-1	TRANSPORT TO RADIAL ARM SAW					
○ ⇨ □ D ▽	O-2	CUT TO LENGTH				RADIAL ARM SAW	STOP BLOCK
○ ⇨ □ D ▽	I-1	INSPECT SIZE OF BLOCK					GO-NO GO GAUGE
○ ⇨ □ D ▽	T-2	TRANSPORT TO TABLE SAW					
○ ⇨ □ D ▽	O-3	CUT GROOVES IN TOP				TABLE SAW	
○ ⇨ □ D ▽	T-3	TRANSPORT TO DRILL #1					
○ ⇨ □ D ▽	O-4	DRILL MARBLE HOLES (TWIST BIT)				DRILL PRESS	JIG #1
○ ⇨ □ D ▽	T-4	TRANSPORT TO DRILL PRESS #2					
○ ⇨ □ D ▽	O-5	DRILL MARBLE STORAGE HOLES (SPADE BIT)				DRILL PRESS	JIG #2
○ ⇨ □ D ▽	I-2	INSPECT DEPTH OF HOLES					GO-NO GO GAUGE
○ ⇨ □ D ▽	T-5	TRANSPORT TO DISC SANDER					
○ ⇨ □ D ▽	O-6	BEVEL EDGES				DISC SANDER	FIXTURE #1
○ ⇨ □ D ▽	T-6	TRANSPORT TO FINISHING TABLE					
○ ⇨ □ D ▽	O-7	HAND SAND				SAND PAPER	
○ ⇨ □ D ▽	O-8	APPLY OIL FINISH				RAGS AND FINISH	
○ ⇨ □ D ▽	D-1	ALLOW FINISH TO DRY					
○ ⇨ □ D ▽	I-3	INSPECT QUALITY					
○ ⇨ □ D ▽	T-8	TRANSPORT TO FINAL ASSEMBLY TABLE					

PRODUCT MANUFACTURING
UNIT VI

HANDOUT #2 — FLOW PROCESS CHART

PRODUCT NAME TIC-TAC-TOE
PART NAME SLIDE
PART NUMBER 2 **DATE** _/_/_

CHART BEGINS O-9
CHART ENDS T-11

○ OPERATIONS 4
D DELAYS 1
□ INSPECTIONS 1
▽ STORAGES 0
⇨ TRANSPORTATIONS 3
TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
[✓ ○] ⇨ □ D ▽	O-9	CUT (PRESAWN-THICKNESS AND WIDTH) MATERIAL TO LENGTH				BAND SAW	JIG #3
○ ⇨ [✓ □] D ▽	I-4	INSPECT SIZE					GO-NO GO GAUGE
○ [✓ ⇨] □ D ▽	T-9	TRANSPORT TO WORK STATION #1					
[✓ ○] ⇨ □ D ▽	O-10	DRILL HOLE FOR SCREW				HAND DRILL TWIST BIT	JIG #4
○ [✓ ⇨] □ D ▽	T-10	TRANSPORT TO FINISH TABLE					
[✓ ○] ⇨ □ D ▽	O-11	HAND SAND				SAND PAPER	
[✓ ○] ⇨ □ D ▽	O-12	APPLY OIL FINISH				RAGS AND FINISH	
○ ⇨ □ [✓ D] ▽	D-2	ALLOW FINISH TO DRY					
○ [✓ ⇨] □ D ▽	T-11	TRANSPORT TO FINAL ASSEMBLY TABLE					
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
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○ ⇨ □ D ▽							
○ ⇨ □ D ▽							

PRODUCT MANUFACTURING
UNIT VI

HANDOUT #3 — FLOW PROCESS CHART

PRODUCT NAME TIC-TAC-TOE

PART NAME FINAL ASSEMBLY

PART NUMBER 1&2 **DATE** _/_/_

CHART BEGINS O-13

CHART ENDS S-1

○ OPERATIONS 3
D DELAYS 0
□ INSPECTIONS 1
▽ STORAGES 1
⇨ TRANSPORTATIONS 1
TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
[✓ ○] ⇨ □ D ▽	O-13	ASSEMBLE SLIDE TO BLOCK WITH DECORATIVE SCREW				SCREW DRIVER	
○ ⇨ [✓ □] D ▽	I-5	INSPECT QUALITY					
[✓ ○] ⇨ □ D ▽	O-14	LOAD TWO SETS OF MARBLES					
[✓ ○] ⇨ □ D ▽	O-15	PACKAGE PRODUCT					
○ [✓ ⇨] □ D ▽	T-12	TRANSPORT TO STORAGE					
○ ⇨ □ D [✓ ▽]	S-1	STORE UNTIL SOLD					
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
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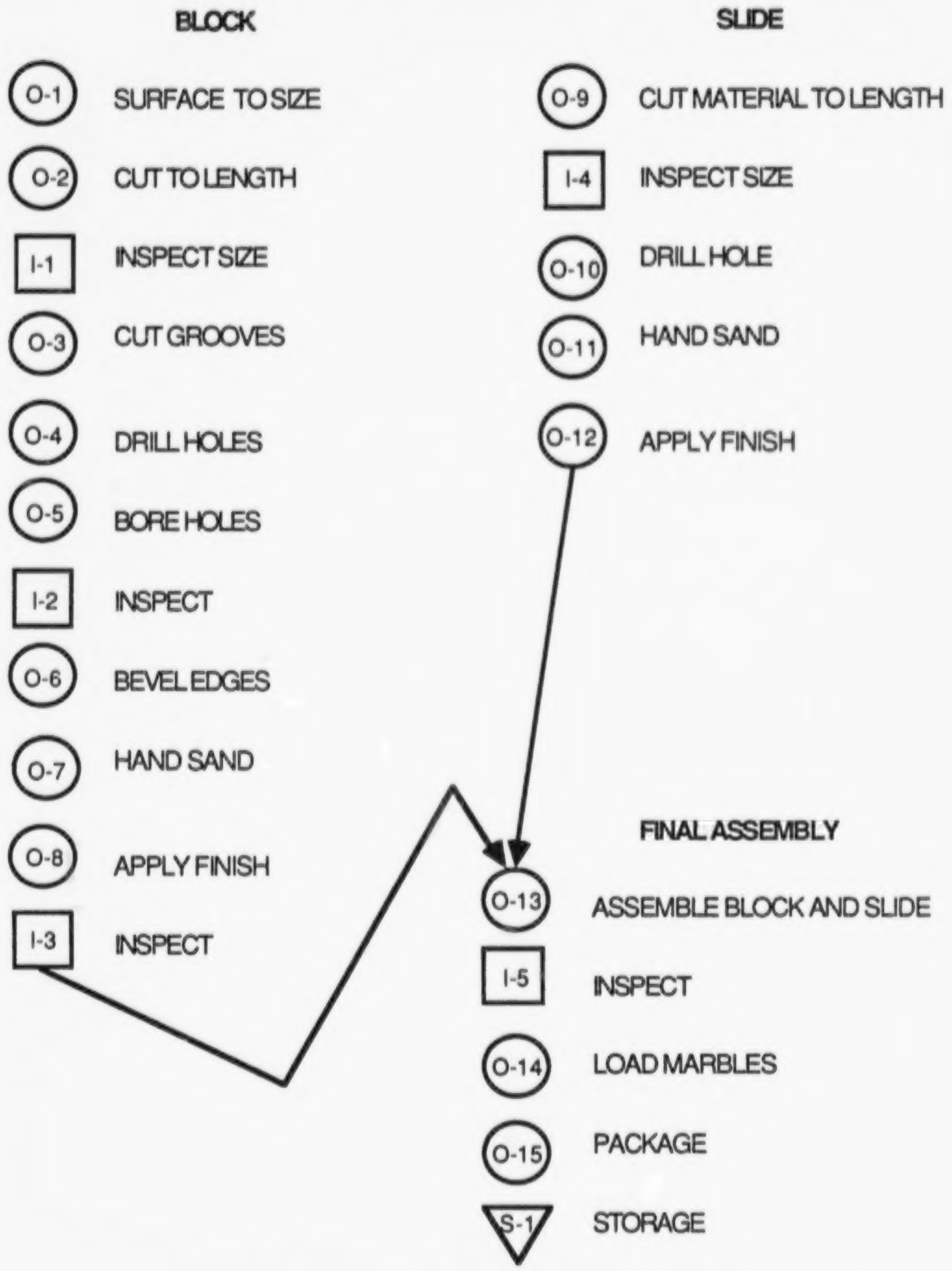
PRODUCT MANUFACTURING
UNIT VI

HANDOUT #4 — OPERATION PROCESS CHART
(FOR TIC-TAC-TOE)


BLOCK
O-1 SURFACE TO SIZE
O-2 CUT TO LENGTH
I-1 INSPECT SIZE
O-3 CUT GROOVES
O-4 DRILL HOLES
O-5 BORE HOLES
I-2 INSPECT
O-6 BEVEL EDGES
O-7 HAND SAND
O-8 APPLY FINISH
I-3 INSPECT
SLIDE
O-9 CUT MATERIAL TO LENGTH
I-4 INSPECT SIZE
O-10 DRILL HOLE
O-11 HAND SAND
O-12 APPLY FINISH
FINAL ASSEMBLY
O-13 ASSEMBLE BLOCK AND SLIDE
I-5 INSPECT
O-14 LOAD MARBLES
O-15 PACKAGE
S-1 STORAGE

PRODUCT MANUFACTURING
UNIT VI

HANDOUT #5 — OPERATION ANALYSIS SHEET

Operation No. : O-5

Product: TIC-TAC TOE

Operation Name : DRILL MARBLE STORAGE HOLES

Part Name: Block

Part No.: 1

Quantity: 50

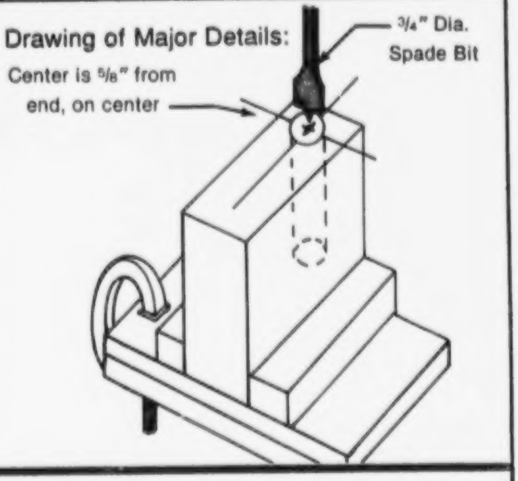
Stock/ Material: Pine

Tools/ Equipment: Drill Press
3/4" Spade Bit
Brush

Jigs / Fixtures: Jig #2

Supplies:

Drawing of Major Details:

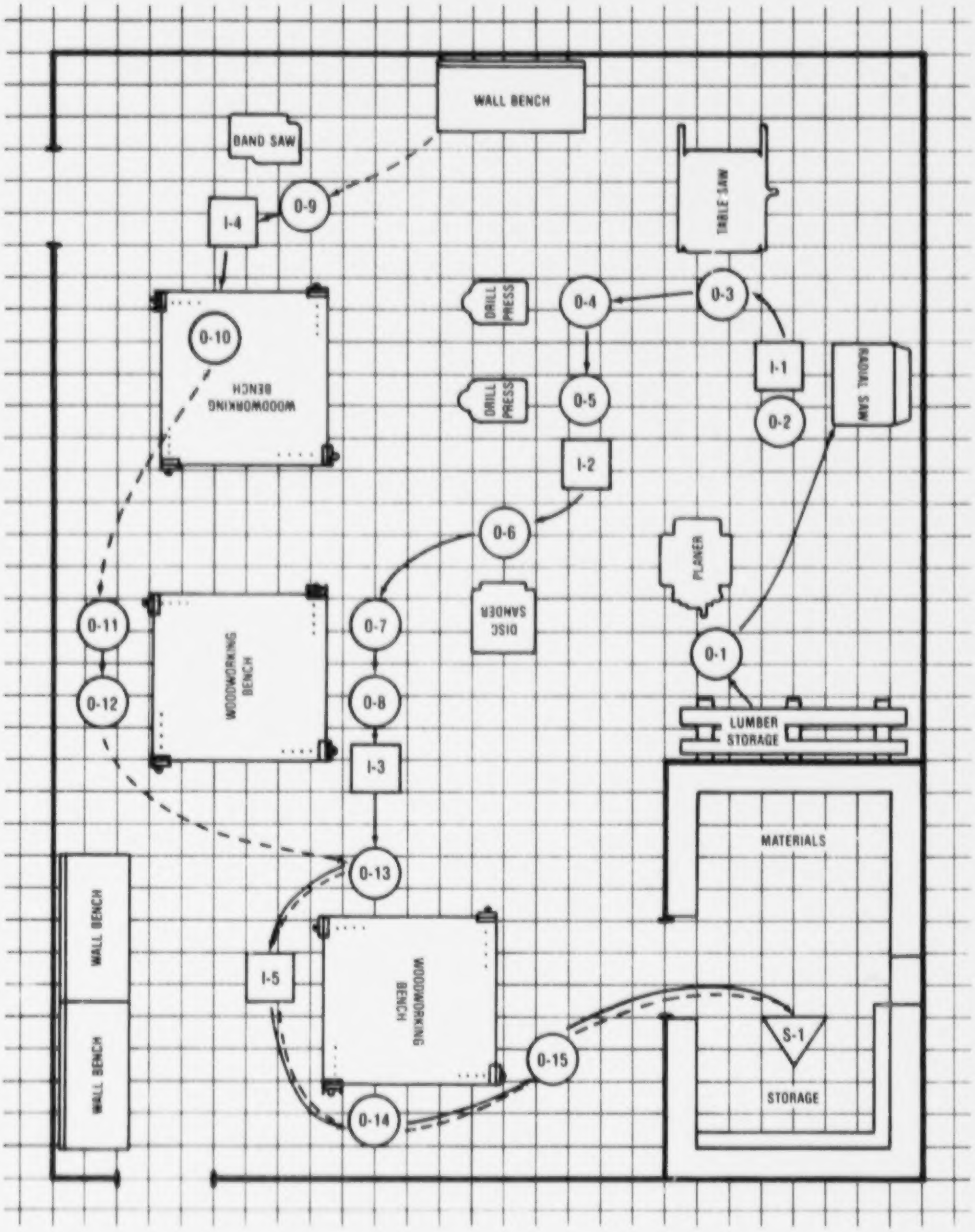


Operation Description:

Step No.	Description of Step	Materials	Machine	Tools and Equipment
1	Insert Tic-Tac-Toe body into drill jig, and turn on machine.	Pine	Drill Press	Jig #2 3/4" Spade Bit
2	Drill 3/4" dia. hole to the depth of 2-1/2" , and shut off drill press. Set-up done previously.	Pine	Drill Press	Jig #2 3/4" Spade Bit
3	Remove T-T-T body and rotate 180 °. (Note: Be sure to clear sawdust from jig.)	Pine	Drill Press	Jig #2 3/4" Spade Bit Brush
4	Repeat steps #1 & #2	Pine	Drill Press	Jig #2 3/4" Spade Bit
5	Place T-T-T body in box for inspection.	Pine	Drill Press	

PRODUCT MANUFACTURING
UNIT VI

HANDOUT #6 — PLANT LAYOUT AND FLOW DIAGRAM
(FOR TIC-TAC-TOE)


WALL BENCH
BAND SAW
TABLE SAW
0-9
I-4
0-10
WOODWORKING BENCH
DRILL PRESS
0-4
0-3
I-1
RADIAL SAW
0-2
DRILL PRESS
0-5
I-2
0-6
PLANER
DISC SANDER
0-11
0-12
WOODWORKING BENCH
0-7
0-8
I-3
0-1
LUMBER STORAGE
MATERIALS
0-13
WALL BENCH
I-5
WOODWORKING BENCH
WALL BENCH
0-15
S-1
STORAGE
0-14

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #1 — COMPLETE A FLOW PROCESS CHART

NAME ______________________ SCORE ______________________

Directions: Fill in the symbol, task numbers, and other information. Use the information based on the description of tasks for the Desk Gadget, or the information from your instructor for the product your class is going to produce.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Handouts #1-#3 — Flow Process Charts for Tic-Tac-Toe.

Step 1. Fill in the following information in Figures 1, 2, 3, and on the "Description of Tasks" found on the "Desk Gadget" sheets.

A. Symbols — Connect with line

B. Task-numbers

C. Totals — Operation, inspection, etc.

D. Chart beginning and ending information

E. Date

Step 2. After successfully completing (teacher grades) the "Desk Gadget" Flow Process Chart," complete the blank "Flow Process Chart," (Figure 4) for one of the parts of your mass produced products. This will be assigned by your instructor.

ASSIGNMENT SHEET #1

FLOW PROCESS CHART

PRODUCT NAME DESK GADGET **CHART BEGINS** ____

PART NAME BASE **CHART ENDS** ____

PART NUMBER 1 **DATE** __/__/__

○ OPERATIONS ___ D DELAYS ___
□ INSPECTIONS ___ ▽ STORAGES ___
⇨ TRANSPORTATIONS ___ TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○⇨□D▽		CUT TO LENGTH				RADIAL ARM SAW	STOP BLOCK
○⇨□D▽		INSPECT SIZE					GO-NO GO GAUGE
○⇨□D▽		TRANSPORT TO WORK STATION #1					
○⇨□D▽		DRILL 3 HOLES (TWIST BIT)				HAND DRILL	FIXTURE #1
○⇨□D▽		TRANSPORT TO DRILL PRESS					
○⇨□D▽		DRILL 4 PENCIL HOLES (TWIST BIT)				DRILL PRESS	FIXTURE #2
○⇨□D▽		INSPECT DEPTH OF HOLES					GO-NO GO GAUGE
○⇨□D▽		TRANSPORT TO FINISH TABLE					
○⇨□D▽		HAND SAND				SAND PAPER	
○⇨□D▽		APPLY FINISH				RAGS AND FINISH	
○⇨□D▽		ALLOW FINISH TO DRY					
○⇨□D▽		TRANSPORT TO FINAL ASSEMBLY TABLE					
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							

ASSIGNMENT SHEET #1

FLOW PROCESS CHART

PRODUCT NAME DESK GADGET
PART NAME FRAME
PART NUMBER 2 **DATE** __/__/__

CHART BEGINS ________
CHART ENDS ________

○ OPERATIONS ___	D DELAYS ___
□ INSPECTIONS ___	▽ STORAGES ___
⇨ TRANSPORTATIONS ___	TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○⇨□D▽		TRANSPORT PRECUT ACRYLIC FROM STORAGE TO WORK STATION #2					
○⇨□D▽		DRILL 3 HOLES (TWIST BIT)				HAND DRILL	FIXTURE #3
○⇨□D▽		SMOOTH EDGES				FILE, SAND PAPER	
○⇨□D▽		TRANSPORT TO BUFFER					
○⇨□D▽		POLISH EDGES				BUFFER	
○⇨□D▽		INSPECT EDGES					
○⇨□D▽		TRANSPORT TO WORK STATION #3					
○⇨□D▽		BEND ENDS				STRIP HEATER	JIG #1
○⇨□D▽		INSPECT BENDS					TEMPLATE
○⇨□D▽		TRANSPORT TO FINAL ASSEMBLY TABLE					
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							

ASSIGNMENT SHEET #1

FLOW PROCESS CHART

PRODUCT NAME DESK GADGET
PART NAME CLIP
PART NUMBER 3 **DATE** __/__/__

CHART BEGINS __________
CHART ENDS __________

○ OPERATIONS ___ D DELAYS ___
□ INSPECTIONS ___ ▽ STORAGES ___
⇨ TRANSPORTATIONS ___ TIME ___

Symbols	Task No.	Description of Task	Quantity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○ ⇨ □ D ▽		CUT TO SIZE, LENGTH AND WIDTH				SQUARING SHEARS	
○ ⇨ □ D ▽		INSPECT SIZE					
○ ⇨ □ D ▽		TRANSPORT TO WORK STATION #4					
○ ⇨ □ D ▽		FILE EDGES				HAND FILE	
○ ⇨ □ D ▽		PUNCH HOLE				HAND PUNCH	
○ ⇨ □ D ▽		BEND TO SHAPE				VISE, HAMMER	JIG #2
○ ⇨ □ D ▽		INSPECT SHAPE					TEMPLATE
○ ⇨ □ D ▽		TRANSPORT TO FINAL ASSEMBLY TABLE					
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							
○ ⇨ □ D ▽							

ASSIGNMENT SHEET #1

FLOW PROCESS CHART

PRODUCT NAME DESK GADGET
PART NAME FINAL ASSEMBLY
PART NUMBER 1,2,3 **DATE** __/__/__

CHART BEGINS ____________
CHART ENDS ____________

○ OPERATIONS ___ D DELAYS ___
☐ INSPECTIONS ___ ▽ STORAGES ___
⇨ TRANSPORTATIONS ___ TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○ ⇨ ☐ D ▽		ASSEMBLE BASE, FRAME, AND CLIP				SCREW DRIVER	
○ ⇨ ☐ D ▽		INSPECT QUALITY					
○ ⇨ ☐ D ▽		INSERT CARDBOARD BACKING					
○ ⇨ ☐ D ▽		APPLY STRIP THERMOMETER					
○ ⇨ ☐ D ▽		PACKAGE					
○ ⇨ ☐ D ▽		TRANSPORT TO STORAGE					
○ ⇨ ☐ D ▽		HOLD FOR DISTRIBUTION					
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							
○ ⇨ ☐ D ▽							

ASSIGNMENT SHEET #1

FLOW PROCESS CHART

PRODUCT NAME ________________ **CHART BEGINS** ____________

PART NAME ________________ **CHART ENDS** ____________

PART NUMBER ___ **DATE** __/__/__

○ OPERATIONS ___ D DELAYS ___
□ INSPECTIONS ___ ▽ STORAGES ___
⇨ TRANSPORTATIONS ___ TIME ___

Symbols	Task No.	Description of Task	Quanity	Distance (ft)	Time (min.)	Machine Required	Tooling Required
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
○⇨□D▽							
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○⇨□D▽							
○⇨□D▽							

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #2 — DEVELOP AN OPERATION PROCESS CHART

NAME ____________________ SCORE ____________________

Directions: Sketch an operation process chart for the Desk Gadget based on its flow process charts and the product your class is going to produce. Use the appropriate symbols.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Handout #4 — Operation process chart for Tic-Tac-Toe.

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #3 — COMPLETE AN OPERATION ANALYSIS SHEET

NAME ____________________ SCORE ____________________

Directions: Complete an operation analysis sheet for one of the operations on the Flow Process Chart for the product being mass-produced by your class. The operation will be assigned by your instructor.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Handout #5 — Operation Analysis Sheet for Tic-Tac-Toe (Drill Marble Storage Holes)

ASSIGNMENT SHEET #3

OPERATION ANALYSIS SHEET

Operation No. : ________

Product: ____________________

Operation Name : ____________________________

Part Name: ____________________

Part No.: ____________________

Quantity: ____________________

Stock/
Material: ____________________
____

Tools/
Equipment: ____________________
____
____

Jigs /
Fixtures: ____________________
____

Supplies: ____________________
____
____

Drawing of Major Details:

Operation Description:

Step No.	Description of Step	Materials	Machine	Tools and Equipment

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #4 — DESIGN A JIG OR FIXTURE

NAME ______________________ SCORE ______________________

Directions: Sketch the tooling needed for the operation assigned to you by your instructor on grid paper. Design it to ensure speed, accuracy, and safety in completing the operation. Note the machine it is used on and how the part is secured in the tooling.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Assignment Sheet #3 — Operation analysis sheet for the particular operation assigned by your instructor.

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #5 — MAKE A PLANT LAYOUT AND DEVELOP A FLOW DIAGRAM

NAME ____________________ SCORE ____________________

Directions: Using the templates and grid paper provided by your instructor, sketch an appropriate Plant Layout and Flow Diagram of your lab for the Desk Gadget or the product your class plans to produce.

A. Make a scale drawing of your lab.

B. Cut out templates for the needed machines and equipment for the Desk Gadget or your class product.

C. Place the templates on the scale drawing and arrange them so there will be a smooth production run. You may have to arrange the templates several times to get the most efficient one.

D. Glue or tape the templates down.

E. Draw arrows and lines to show direction of product travel through the system.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Handouts #1-6

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #6 — DESIGN AN INSPECTION GAGE

NAME ______________________ SCORE ______________________

Directions: Sketch the inspection gage assigned to you by your instructor on grid paper. Design the gage for the appropriate inspection need(s) assigned to you (e.g. depth of holes).

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #7 — COMPLETE A JOB DESCRIPTION

NAME ______________________ SCORE ______________________

Directions: Complete a job description for the person who will perform the operation you described on the Operation Analysis Sheet or one assigned by your instructor. Be sure to complete all information requested.

Evaluation: You will be evaluated on neatness, completeness, and accuracy.

Reference: Assignment Sheet #3 — Operation Analysis Sheet

PRODUCT MANUFACTURING
UNIT VI

ASSIGNMENT SHEET #8 — COMPLETE A JOB APPLICATION FORM

NAME ______________________ SCORE ______________________

Directions: Complete the following application form using the guidelines below.

(NOTE: Although each business uses its own form, general rules of preparation apply to any form.)

1. Be prepared.
   a. Take a good ink pen with you.
   b. Take copies of resume.
2. Look over entire form before starting to write; do not hurry.
3. Follow directions.
4. Write or print clearly, neatly, and legibly.
5. Answer briefly.
6. Be honest.
7. Answer all questions.

   (NOTE: If questions do not apply to you, write Not Applicable or NA in the space to show that you did not overlook the question.)
8. Include complete information; use resume.
9. Recheck application when finished.
10. Avoid cross-outs and obvious erasure marks.

ASSIGNMENT SHEET #8

____
(Date)

APPLICATION FOR EMPLOYMENT

PRINT IN INK OR TYPE

Personal Data:

Last Name ________________ First ________________ Middle ________________

Address ____

City, State, Zip ____

Home Phone (____) ____ - ________ Work Phone (____) ____ - ________

If you have no phone, name of person and phone number where we may leave a message for you __________

____

Social Security Number ____ - ____ - ________

Education Data:

SCHOOL	NAME & LOCATION OF SCHOOL	COURSE OF STUDY OR MAJOR/MINOR	NO. OF YEARS OR HOURS COMPLETED	DIPLOMA OR CERTIFICATE RECEIVED
Junior High				
High School				
Vocational-Technical School				
College/ University				
Other				

Employment Data: (Start with present or most recent employment)

1. Company ____________________ Telephone (____) ____ - ________

Address ____________________ Employed from ________ to ________

Name of Supervisor ________________ Part-time ☐ Full-time ☐

Job Title and Type of Duties Performed Reason for Leaving

________________________ ________________________

________________________ ________________________

ASSIGNMENT SHEET #8

2. Company ______________________ ( ) ______________________

Address ______________________ from __________ to __________

Name of Supervisor ______________________ ☐ Full-time ☐

Job Title and Type of Duties Performed Reason for Leaving

______________________ ______________________

______________________ ______________________

3. Company ______________________ Telephone ( ) ______________________

Address ______________________ Employed from __________ to __________

Name of Supervisor ______________________ Part-time ☐ Full-time ☐

Job Title and Type of Duties Performed Reason for Leaving

______________________ ______________________

______________________ ______________________

May we contact the employers listed above in regard to your job performance?

Yes ☐ No ☐ Specify ______________________

References:

1. Name ______________ Address ______________ Phone ______________
2. Name ______________ Address ______________ Phone ______________
3. Name ______________ Address ______________ Phone ______________

May we contact the references listed above in regard to your job performance?

Yes ☐ No ☐ Specify ______________________

Application:

Have you ever worked for us before? Yes ☐ No ☐ If yes, what position(s)?

____

Type of position(s) desired

1. ______________ 2. ______________ 3. ______________

Date available to begin work ______________

Please describe below why you would be an asset to this company if you were hired. List experience, skills, and training that qualify you for the applied position. Be specific.

____

____

____

____

____

____

Equal Opportunity Employer

PRODUCT MANUFACTURING
UNIT VI

TEST

NAME ____________________ SCORE ____________________

1. Match the terms on the right with their correct definitions.

_____a. The measure of production output per unit of labor for production

_____b. Process of negotiating a contract between management and labor

_____c. Activities resulting in the manufacture of a product

_____d. Something produced in addition to the main product

_____e. A specific piece of equipment designed to do a specific process

_____f. Standard part or components combined to produce sections of a finished product

_____g. Combination of subassemblies and/or components

_____h. Only one of a series of specific actions done to produce a part, the collection of which makes up a job for the worker

_____i. The operation of machines and processing equipment without an operator controlling them; usually control is by a computer

_____j. A reprogrammable, multifunctional machine capable of movement and performing a variety of tasks

_____k. An organization of workers that tries to avoid problems and work out solutions between employees and management

1. Assembly
2. Automation
3. By-product
4. Collective bargaining
5. Contract
6. Finished product
7. Inspection
8. Machine
9. Mechanization
10. Operation
11. Process
12. Production
13. Productivity
14. Robot
15. Specification
16. Subassembly
17. Union

TEST

_____l. Compares the product against quality standards to see if it meets specifications

_____m. The equipping of industry with machines for production work

2. Select from the list the three factors that determine how a manufacturing enterprise is organized.

_____a. Resources available

_____b. Environmental considerations

_____c. Utilization factors

_____d. Quantity desired (at a given time)

_____e. Quality desired

3. Select from the following list the two types of manufacturing production methods.

_____a. Mass production

_____b. Limited production

_____c. Finish production

_____d. Custom production

4. Distinguish between the two common types of mass production by placing the following letters in the appropriate blanks.

C — Continuous manufacturing
I — Intermittent manufacturing

_____a. Used when volume of product needed is relatively low

_____b. Products are manufactured in lots or groups

_____c. Utilizes automation and mechanization to reduce labor needs and operations

_____d. In primary processing it's called "batch processing"; in secondary it's called "job-lot manufacturing"

_____e. Products move down the line at a continuous speed and predetermined rate

TEST

_____f. Used when large quantities of a product are needed

_____g. Often called "job shops"

_____h. Product flow does *not* stop at any time

5. Select from the following list the key principles of mass production by placing an "X" next to appropriate statements.

_____a. Parts are custom made and must be fitted individually

_____b. Each worker does a wide variety of jobs

_____c. Wasted time and motion are eliminated

_____d. Parts are duplicated accurately to make interchangeability possible

_____e. Tools, equipment, and workers are placed in the sequence operations need to be done

_____f. Each worker does a specific job

6. Complete statements concerning the components needed for production by placing the answers in the appropriate blanks.

_____a. Activities designed to keep defective items from being produced are called:
1) Industrial (manufacturing) engineering
2) Production planning and control
3) Material handling
4) Materials and employees
5) Quality control

_____b. Activities involving routing, loading, scheduling, and dispatching are considered:
1) Industrial (manufacturing) engineering
2) Production planning and control
3) Material handling
4) Materials and employees
5) Quality control

_____c. Group of individuals that develop the methods, means, and facilities to produce products are called:
1) Industrial (manufacturing) engineering
2) Production planning and control
3) Material handling
4) Materials and employees
5) Quality control

TEST

7. Complete statements concerning the responsibilities of industrial engineering by placing answers in appropriate blanks.

_____a. Jigs and fixtures and patterns and templates are most closely associated with:
   1) Materials handling
   2) Improvement of manufacturing system
   3) Selection and sequence of operations
   4) Tooling
   5) Plant layout

_____b. Moving materials throughout the plant is most closely associated with:
   1) Materials handling
   2) Improvement of manufacturing system
   3) Selection and sequence of operations
   4) Tooling
   5) Plant layout

_____c. *Planning* the use of all floor space for positioning equipment for operations in a manufacturing facility is most closely associated with:
   1) Materials handling
   2) Improvement of manufacturing system
   3) Selection and sequence of operations
   4) Tooling
   5) Plant layout

8. Match methods for the selection and sequence of manufacturing operations (and their components) with their correct descriptions and examples.

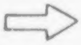
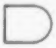
_____a. Inspection

_____b. Object is moved from one location to another

_____c. Movement of *material* is drawn on the plant layout floor plan

_____d. A graphic that shows sequence of tasks (including operations, inspections, etc.) for producing a single part. Does *not* show overall manufacture

_____e. Object is modified or changed; Example: drill hole

1. Operation analysis sheet
2. Flow process chart
3.
4.
5. 
6. 
7. Ex.: Check depth
8. Storage

TEST

______f. Object waits for its next operation; held until ready

______g. Graphic shows flow of *component parts* or objects being produced; drawn on a floor plan of manufacturing plant

______h. List steps and operations necessary to manufacture a specific product; including name of operation, machine used, tooling needed

______i. Chart shows *all* the operations in the order in which part is manufactured

______j. Object is put in a protected location

9. Operation process chart
10. Product flow diagram
11. Handling plan
12. Material flow diagram

9. Select the three major considerations in tooling up by placing an "X" in the appropriate blanks.

______a. What tools are needed to make the product?

______b. What tools are old?

______c. What tools need to be purchased?

______d. What tools involve skilled labor?

______e. What tools need to be made by or for the company?

10. Select the major objectives of tooling by placing an "X" in the appropriate blanks.

______a. Safety

______b. Economy

______c. Speed

______d. Accuracy

______e. Skill

TEST

11. Match the types of tooling required for interchangeability of parts with their correct descriptions and examples.

______a. Gives only the outline of a part; used to aid in layout and trimming of part

______b. Three-dimensional models or forms

______c. Used with machines to hold and support the workpiece *only*

______d. Holds the workpiece *and* guides or locates the tool for a cutting or drilling operation

______e. Used to trim materials to proper size and to generate irregular holes or shapes of the correct size and shape

______f. Used to control the forming or shaping of materials

______g. Used for checking the dimensional accuracy of parts; inspection and quality control devices

1. Jigs
2. Gages
3. Charts
4. Dies and molds
5. Templates
6. Fixtures
7. Cutting dies, special punches, special tools
8. Patterns

12. Select the considerations in plant layout by placing an "X" next to items in the following list.

______a. Jigs and fixtures required

______b. Location of aisles for movement of people and materials

______c. Movement of materials

______d. Height of ceilings

______e. Location of utilities for hookups of electricity, water, gas, air, etc.

______f. Location of machines

13. Distinguish between the two basic types of plant layout by placing the following letters next to appropriate statements.

PCS — Process layout
PDT — Product layout

______a. Generally used for continuous manufacturing

______b. Departments are formed in this type of layout; example: inspection, finishing

TEST

_____c. Machines are grouped according to the processes they perform

_____d. Used to manufacture a large number of a few products

_____e. Used for custom and some intermittent manufacturing

_____f. Workstations are arranged according to sequence of operation

14. Select the characteristics of a good material-handling system by placing an "X" next to items in the following list.

_____a. Should rely heavily upon manpower

_____b. Minimizes how often and how far materials are handled

_____c. Movement of material should be vertical whenever possible

_____d. Uses mechanization to move materials whenever possible

15. Distinguish between the two types of material-handling equipment by placing the following letters next to appropriate statements or examples.

F — Fixed Path
V — Variable path

_____a. Examples are elevators, pipes, chutes, conveyors, "pick and place" robots

_____b. Used in intermittent manufacturing and to load materials in continuous manufacturing

_____c. Examples are hand trucks, fork lifts, overhead cranes; robots following buried cables

_____d. Usually associated with continuous manufacturing

_____e. Material always moves on the same path

_____f. Can move material in various directions; can be steered

TEST

16. Match actions monitored by production planning and control with their definition, description, or example.

______a. Identifies a path the product follows as each operation is performed throughout the plant

______b. Total time it takes to complete the needed operations on a part

______c. Determines the time and place each operation will be performed, thereby regulating the volume of production

______d. Involves issuing production orders to start the work that has been scheduled

______e. Determines if the work is being completed as scheduled

______f. Checks the product quantity and quality against the production plan

1. Dispatching
2. Expediting
3. Loading
4. Monitoring (control)
5. Ranking
6. Routing
7. Saving
8. Scheduling

17. Select the two major functions of quality control by placing an "X" next to the correct functions.

______a. To develop a program that is free of inspections

______b. To develop a program that provides for quality built into the product

______c. To develop an inspection system that eliminates dimensional measuring equipment

______d. To develop an inspection system that checks parts against standards

18. Select from the following list the steps involved in inspections. Place an "X" next to appropriate statements.

______a. Determine appropriate quality standards

______b. Inspect the quality standards

______c. Purchase or build gages to check parts and products

______d. Develop a program to check parts and products periodically

______e. Before, during, and after manufacturing, identify parts that can be salvaged by reworking

TEST

19. Arrange in order the steps in obtaining materials and equipment for production (purchasing procedures) by placing a "1" in front of the first step, a "2" in front of the second, etc.

_____a. Purchase order issued

_____b. Payment made on order

_____c. Shipment and invoice received

_____d. Purchase requisition made

_____e. Shipment accepted

_____f. Quotation requests sent out

20. Complete the following statements concerning the steps in obtaining labor for production by placing answers in the appropriate blanks.

_____a. The first step in obtaining labor for production is:
1) Interview prospective employees
2) Provide training for employees
3) Select employees
4) Determine employees needed

_____b. Having job applications filled out and interviewing prospective employees are most closely associated with:
1) Determining employees needed and developing job descriptions
2) Recruiting and gathering information about job applicants
3) Selecting employees
4) Training employees

21. Select from the following list the attributes an employer looks for in an employee. Place an "X" next to those attributes.

_____a. Enthusiasm and interest

_____b. Dedication and dependability

_____c. Youth and inexperience

_____d. Honesty and integrity

_____e. Desire to work and improve oneself

_____f. Neat and clean in appearance

_____g. Forceful and impatient

TEST

_____h. Unconcerned about neatness and cleanliness

_____i. Decision-making and problem-solving abilities

_____j. Self-centered and opinionated

22. Select from the following list the contents of a labor contract by placing an "X" in the appropriate blanks.

_____a. Historical notes

_____b. Rights of management

_____c. Wages (including overtime)

_____d. Management dress code

_____e. Working hours

_____f. Future direction of company

_____g. Duration of contract

_____h. Employees affected by contract

_____i. Grievance procedures

_____j. Vacations and holidays

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

23. Complete a flow process chart. (Assignment Sheet #1)

24. Develop an operation process chart. (Assignment Sheet #2)

25. Complete an operation analysis sheet. (Assignment Sheet #3)

26. Design a jig or fixture. (Assignment Sheet #4)

27. Make a plant layout and develop a flow diagram. (Assignment Sheet #5)

28. Design an inspection gage. (Assignment Sheet #6)

29. Complete a job description. (Assignment Sheet #7)

30. Complete a job application form. (Assignment Sheet #8)

PRODUCT MANUFACTURING
UNIT VI

ANSWERS TO TEST

1.

a.	13	h.	10
b.	4	i.	2
c.	12	j.	14
d.	3	k.	17
e.	8	l.	7
f.	16	m.	9
g.	1		

2. a, d, e

3. a, d

4.

a.	I	e.	C
b.	I	f.	C
c.	C	g.	I
d.	I	h.	C

5. c, d, e, f

6.

a.	5
b.	2
c.	1

7.

a.	4
b.	1
c.	5

8.

a.	7	f.	6
b.	5	g.	10
c.	12	h.	1
d.	2	i.	9
e.	3	j.	8

9. a, c, e

10. a, c, d

ANSWERS TO TEST

11. a. 5 e. 7
b. 8 f. 4
c. 6 g. 2
d. 1

12. b, c, e, f

13. a. PDT
b. PCS
c. PCS
d. PDT
e. PCS
f. PDT

14. b, d

15. a. F d. F
b. V e. F
c. V f. V

16. a. 6 d. 1
b. 3 e. 2
c. 8 f. 4

17. b, d

18. a, c, d, e

19. a. 3 d. 1
b. 6 e. 5
c. 4 f. 2

20. a. 4
b. 2

21. a, b, d, e, f, i

22. b, c, e, g, h, i, j

23.-30. Evaluated to the satisfaction of the instructor

PRODUCT MARKETING
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to design a package and an advertisement to market the class's product. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to product marketing with the correct definitions.
2. Match major activities of marketing with the correct definitions.
3. Complete statements concerning elements of a marketing plan.
4. Select from a list the purposes of market research.
5. Select from a list reasons for doing a market survey.
6. Select from a list methods used to conduct market research.
7. Arrange in order the stages in a product's life cycle.
8. Select from a list the functions of advertising.
9. Arrange in order the basic steps in preparing an advertisement.
10. Select from a list the principal elements of an advertisement.
11. List media used for advertisements.
12. Select from a list the items in a profile of potential customers.

OBJECTIVE SHEET

13. Select from a list the main functions of a package.
14. Match types of packaging and packaging processes with the correct descriptions.
15. Select from a list the considerations in package selection.
16. Select from a list the design considerations for packages.
17. Select from a list the items include in or on a package.
18. Distinguish between inventory and inventory control.
19. Select from a list the categories of inventory.
20. Complete statements regarding the status of products prior to distribution.
21. Match the automated systems for storage, retrieval, and delivery with the correct descriptions.
22. Select from a list important elements of sales planning.
23. Select from a list the information a salesperson must know.
24. List the two parts of a sales system.
25. Arrange in order the steps in a sales presentation.
26. Identify the parts of a sales order form.
27. Distinguish between the two major methods of distributing goods.
28. List ways to distribute and ship products.
29. Match the stages of product use cycle with their descriptions or examples.
30. Design an advertisement to promote and sell your product. (Assignment Sheet #1)
31. Design a package for your product. (Assignment Sheet #2)

PRODUCT MARKETING
UNIT VII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Show examples of the different types of packages.
2. Have your students produce packages for the mass production items.
3. Problem Solving: Egg Package

   a. Students are given the following materials:

      6 — #18 rubber bands
      6 — 8½ × 11 sheets of paper (can recycle old duplicated sheets)
      18" of masking tape
      2 — Regular paper clips (optional)

   b. The students are instructed to design a package that meets the following criteria:

      1) Can protect the egg from cracking when it is dropped from a height of 15 feet.

      2) Allow the egg to be placed inside prior to the drop and allow for the egg's easy removal. It should not take more than *1* minute to either package the egg or remove it. The package must be reusable for packing another egg.

      3) Must accommodate a "Grade A *Large* Egg."

      (NOTE: Other size eggs may be substituted. Typically, larger eggs break more easily.)

SUGGESTED ACTIVITIES

c. Students may either work on their activity in class or it could be an assigned problem that can be worked on at home over a one week period.

(NOTE: Plastic eggs could be substituted during the research and development of the activity.)

3. Use films and videotapes whenever appropriate.

4. Make certain all excess production materials have been stored or removed from the laboratory.

5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

A. Bame, E. Allen and Paul Cummings. *Exploring Technology*. Worcester, MA: Davis Publications, Inc., 1980.

B. Heiner, Carl W. and Wayne R. Hendrix. *People Create Technology*. Worcester, MA: Davis Publications, Inc., 1980.

C. *Industrial Education: Materials & Processes*, C.B.I.E. Project, Kansas State Department of Education, Topeka, 1986.

D. *Secondary Exploration of Technology*. Kansas State College of Pittsburg, The State Department of Education, Topeka, 1974.

E. Wright, R. Thomas and Richard M. Henak. *Exploring Technology*. South Holland, IL: Goodheart-Willcox Co., 1972.

PRODUCT MARKETING
UNIT VII

INFORMATION SHEET

I. **Terms and definitions**

A. Bar code — A series of vertical lines and spaces of varying widths and/or colors used to encode information, which can be read by a scanning device

Example: Universal Product Code (UPC)

0 24300 04126

B. Consumer — One who purchases goods or services to satisfy needs, rather than to produce other goods

C. Durable goods — Products that are expected to nave a life of three or more years

Examples: Major appliances, automobiles, furniture

D. Maintenance — Keeping a product in good working order so it works properly and can be used longer

E. Marketing — Activities which determine the type, quality, and quantity of products to be produced, and contributes to the sale of products to a consumer

(NOTE: Marketing is the bringing together of those who manufacture products with those who buy them. It is a two-way exchange.)

F. Market survey — A list of questions used with the public to determine the need for or the probable acceptance of a product

G. Middleman — A person (trader) who purchases goods from a producer and sells at wholesale or retail; a go-between

H. Non-durable goods — Products that last fewer than three years

Examples: Food, clothing, paper products

INFORMATION SHEET

- I. Retailer — One who sells goods directly to a consumer
- J. Service — Work that is beneficial to people and/or products
- K. Trademark — A symbol or logo used by a company to identify their goods or services; usually legally registered and protected by law
- L. Warranty — A company's written guarantee regarding a product or service
- M. Wholesaler — One who sells goods in large quantities to a retailer

II. **Major activities of marketing** (Transparency 1)

- A. Market research — A careful study of the wants and needs of potential customers and their reactions to products
- B. Advertising — Communication aimed at increasing public awareness and motivating the consumer to buy a product or a service; a method of teaching consumers about a company or product
- C. Packaging — Containers used to hold products
- D. Sales — The actual exchange of money for products; selling is simply convincing someone to purchase a product
- E. Distribution — Getting the product from the manufacturer to the consumer

III. **Elements of a marketing plan**

- A. Product — Must meet the wants and needs of consumers
- B. Price — Consumers must perceive product's price as a "value" (good deal)
- C. Promotion — Consumers are made aware of product and its good features, typically done through advertising
- D. Distribution — The movement of the product to the customers to make it available upon its sale to them
- E. Service — A method to repair or replace a product should it malfunction or break

IV. **Purposes of market research** (Transparency 2) — To determine:

- A. Who is the consumer and where does she/he live?
- B. What does the consumer need and want?

INFORMATION SHEET

C. What products will the consumer buy?

D. How much will the consumer pay for a product?

E. How and where does the consumer buy a specific product?

V. **Reasons for doing a market survey**

A. Get reactions to a product

B. Determine selling price of product

C. Find out if people intend to buy product

VI. **Methods used to conduct market research**

A. Phone

B. Mail

C. Personal contact

(NOTE: The survey should be well organized and easy to understand.)

VII. **Stages in a product's life cycle** (Transparency 3)

A. Introduction

B. Growth

C. Maturity

D. Decline

E. Obsolescence

(NOTE: Relate this to famous toys, soft drinks, or candy bar products.)

VIII. **Functions of advertising** (Transparency 4)

A. **Attract attention** — Make people want to hear, read, or see more about a product, service, or a company

B. **Inform consumers** — Explain features and advantages to potential customers

C. **Persuade consumers** — Make people want to support idea or use product

D. **Initiate action** — Make people seek product and want to buy it

INFORMATION SHEET

IX. **Basic steps in preparing an advertisement** (Assignment Sheet #1)

A. Develop message (idea people should receive)

B. Design presentation

C. Produce advertisement

X. **Principal elements of an advertisement** (Assignment Sheet #1)

A. Manufacturer's name

B. Selling points and main features

C. Attractive graphic representation or design

XI. **Media used for advertisements**

(NOTE: Advertising employs various media to improve the chances that a customer will see and buy a certain product.)

A. Letters

B. Catalogs

C. Magazines and journals

D. Newspapers

E. Radio

F. Television

G. Billboards

H. Package

(NOTE: When selecting the media, the advertiser should consider the potential consumer's interests. For example, children's cereal would not be effectively advertised in magazines designed for retired persons.)

XII. **Items in a profile of potential consumers**

(NOTE: A profile of potential consumers should be developed to improve advertising effectiveness.)

A. Age range

B. Professional or nonprofessional status

INFORMATION SHEET

C. Sex

D. Interest group (sports, teenagers, retirees, working mothers, etc.)

XIII. **Main functions of a package** (Transparency 5)

A. Promote the product

B. Provide information to the customer — Directions for use, quantity, content, health and safety information, etc.

C. Protect and hold (contain) the product — Protect from breakage, moisture, etc. Contain material for shipping and use.

Example: Padded box for a fragile decoration

XIV. **Types of packaging and packaging processes**

A. Bags — Containers made of paper, fabric, or plastic with an opening on one end that can be closed.

B. Blister packaging — A thermoformed plastic "bubble" of the basic shape of part to be packaged is made. The product is placed inside the "bubble" which is then sealed to a backing material.

C. Skin packaging — Thin layer of plastic film is formed tightly around product

D. Shrink packaging — Plastic is stretched in length and width over product and then heat applied. Heat causes plastic film to shrink.

E. Cardboard and paperboard package — Boxes

(NOTE: There are also special forms of packaging such as cans and tubes that can be used for special products.)

XV. **Considerations in package selection**

A. Product — Including shape, characteristics, form, and quantity

Example: Carton for a dozen eggs

B. Laws — Information required by law concerning weight, measurement, and safety

Example: Box of .22 caliber bullets

C. Market — Preferred method of store display; quantities typically bought, sizes and shapes customers and dealers want

Example: A *pair* of socks

INFORMATION SHEET

D. Cost — Including cost of materials to produce package and of manufacturing and filling it

E. Protecting product — Prevent breakage, destruction, or theft. Also keep contents in and moisture, dirt, grease, etc. out

F. Consumer — Including information regarding how to use, clean, dispose of, etc.

XVI. **Design considerations for packages** (Assignment Sheet #2)

A. Identification of product — Trademark, brand name, etc.

B. Acceptance by customers — Meet customers needs and liking

C. Graphics of package — Color, design, lettering

XVII. **Items included in or on a package** (Transparency 6 and Assignment Sheet #2)

A. Picture of the product (if not visible)

B. Selling price

C. Materials or ingredients used in making product

D. Manufacturer's name and address

E. Essential selling features

F. Instructions on how to use product (if needed) and how to open the package

G. Bar code — Universal Product Code

XVIII. **Definitions of inventory and inventory control**

A. Inventory — List of the amount of material owned by a company

B. Inventory control — Method of keeping track of all materials used by a company; can be done using a computer, manually, or automatically

XIX. **Categories of inventory**

A. Raw materials — Standard stock, basic ingredients

B. Purchased parts — Nuts, bolts, motors, etc. purchased

INFORMATION SHEET

C. Work in process — Materials in use during production

D. Finished goods — Products completely made

XX. **Status of products prior to distribution**

A. Storage — Materials or products deposited in a safe place, usually temporary; final step prior to shipping

(NOTE: Seasonal items and large surpluses are stored in warehouses.)

B. Retrieval — Remove from storage and put back in use or action

C. Delivery — Act of handing over

XXI. **Automated systems for storage, retrieval, and delivery**

A. Automatic Identification (AI) — Computer keeps track of parts and products as they are being produced

B. Just in Time (JIT) — Materials automatically ordered by this delivery program

C. Automatic Guided Vehicle System (AGVS) — Material moved throughout plant, automatically

D. Automated Storage and Retrieval System (ASRS) — Automatically stores and retrieves materials and products

E. Material Requirement Planning (MRP) — Computerized materials inventory control, including ordering

XXII. **Important elements of sales planning** (Transparency 7)

A. Product

B. Price

C. Time

D. Place

E. Quantity

(NOTE: Sales will suffer if any element is wrong.)

INFORMATION SHEET

XXIII. Information a salesperson must know

A. The salesperson's job at the company

B. The product

C. The competition

D. The customer

E. The art of selling

XXIV. Parts of a sales system

A. Sales presentation

B. System for recording sale

XXV. Steps in a sales presentation

A. Introduction of salesperson

Example: Hello, I'm. . .

(NOTE: Some selling requires setting-up and appointment.)

B. Getting attention of customer — Note best features of product, etc.

C. Make sales "pitch" — Present information (e.g. price, how to use, quality, etc.) and build up the customer's desire for the product. Prepare customer to say "yes".

D. Answer customer's questions and objections to buying the product.

(NOTE: Be prepared ahead of time.)

E. Close the sale. Confirm price and complete paper work.

F. Follow-up the sale with reassurance, thanks, and service.

XXVI. Parts of a sales order form (Transparency 8)

A. Customer's name and address

B. Quantity ordered

C. Item ordered

D. Cost (unit and total)

E. Additional information (terms of sale, shipping instructions, taxes, discounts, etc.)

INFORMATION SHEET

XXVII. **Two major methods of distributing goods** (Transparency 9)

A. Direct ("direct sales" or "direct selling") — Manufacturers sell products directly to customers

Examples: Mail order and catalog sales; door-to-door sales of cosmetics, encyclopedias, vacuum cleaners, etc.

B. Indirect ("indirect sales" or "indirect selling") — Manufacturers sell products to a retailer or wholesaler who then sells them to customers.

Example: Department stores, grocery stores

XXVIII. **Ways to distribute and ship product**

A. Mail and delivery services

B. Transportation system — Trucking, rail, air freight

XXIX. **Stages of product use cycle**

A. Install — Product is bought and put into use.

Example: Buying a video cassette recorder (VCR), hooking it up to the television, and plugging it into the electrical outlet

B. Maintain — Preventive maintenance is done to the product to operate properly and increase its useful life.

Example: Cleaning the heads of a VCR with a head cleaner

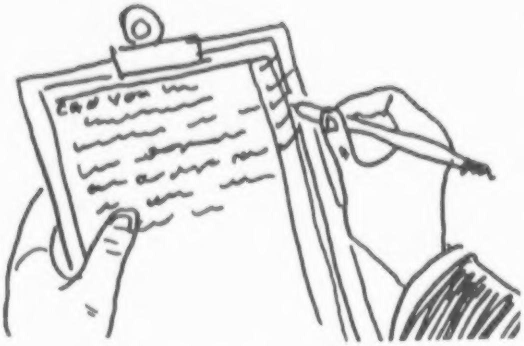
C. Repair — Product fails to operate properly and must be fixed or have parts replaced.

Example: Installing new switch on the VCR

D. Replace — Product is replaced with a new product when it is worn out or too costly to repair

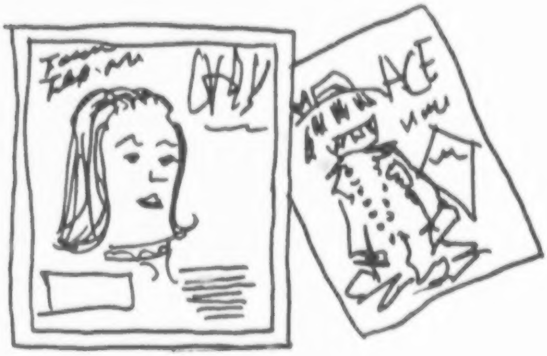
Example: VCR's heads and motors are worn out and the cost of repair is greater than the price of a new machine.

Major Activities of Marketing



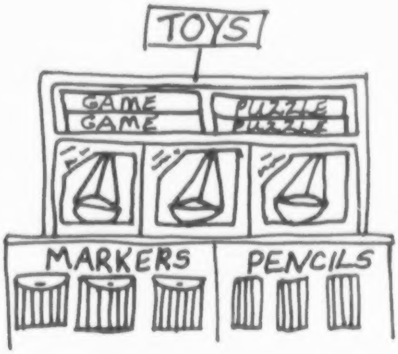
Market Research

TO FIND OUT ABOUT THE MARKET



Advertising

TO PROMOTE PRODUCTS


TOYS
GAME
GAME
PUZZLE
PUZZLE
MARKERS
PENCILS

Packaging

TO CONTAIN PRODUCTS

Sales

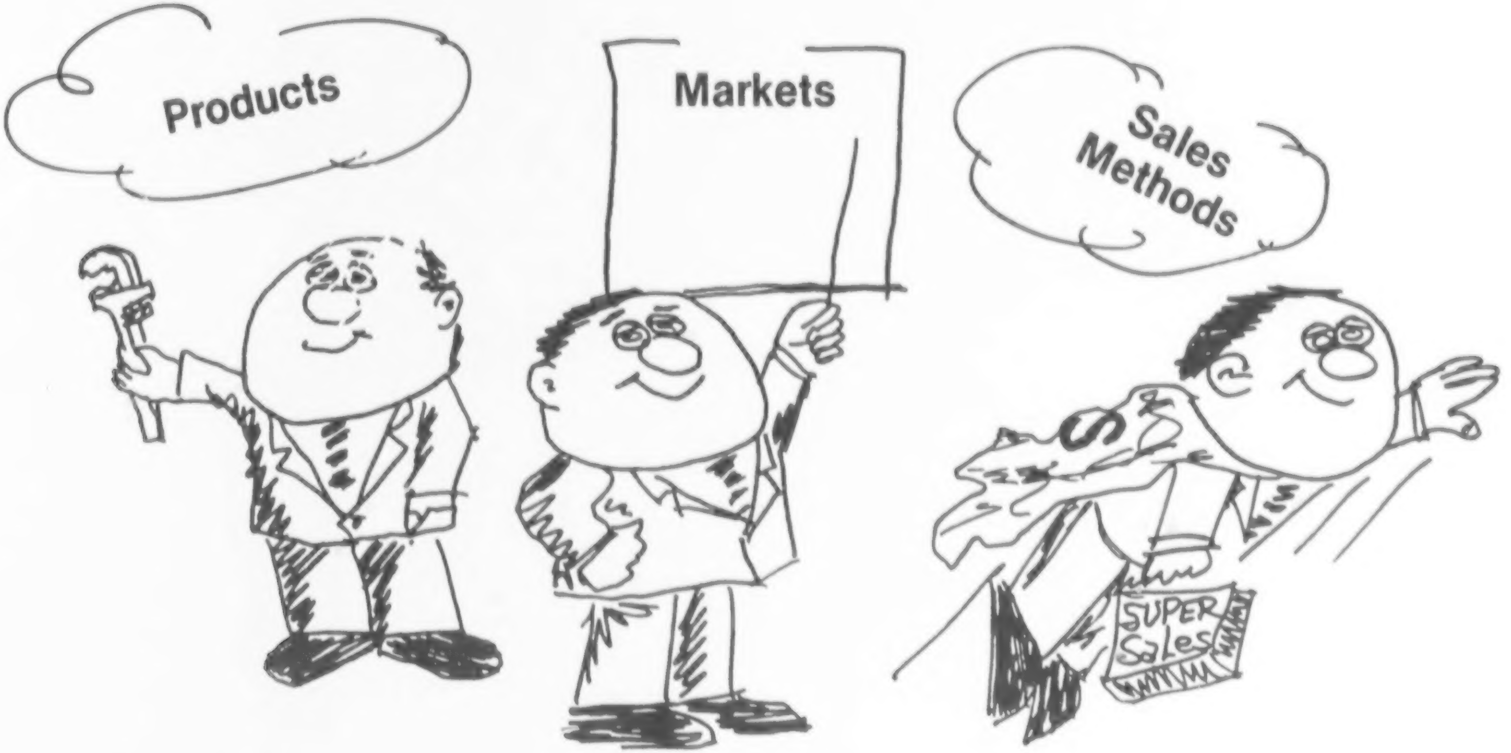
TO SELL PRODUCTS

Distribution

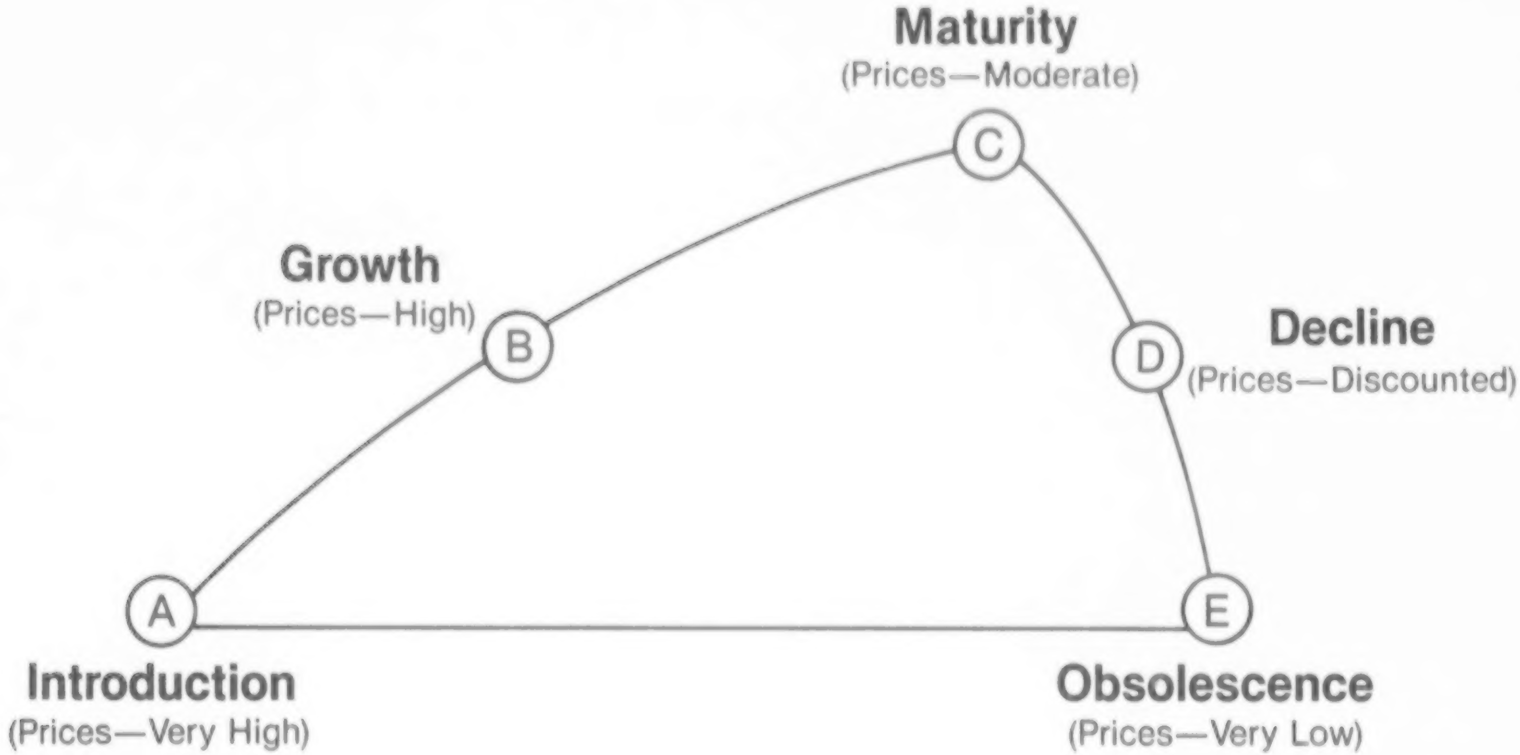
TO DELIVER PRODUCTS

Market Research

Gathers facts related to. . .


Products
Markets
Sales Methods
$
SUPER Sales

Stages in a Product's Life Cycle



Maturity
(Prices—Moderate)

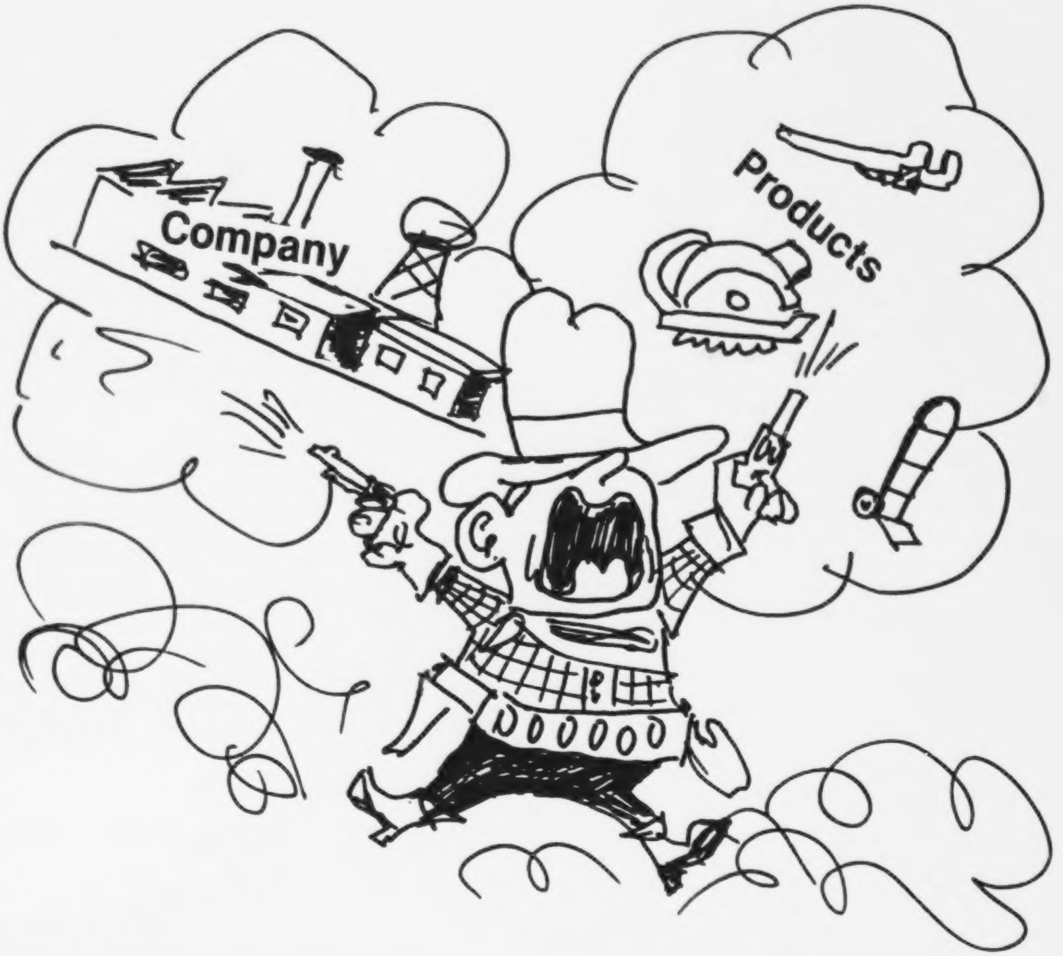
Growth
(Prices—High)

Decline
(Prices—Discounted)

Introduction
(Prices—Very High)

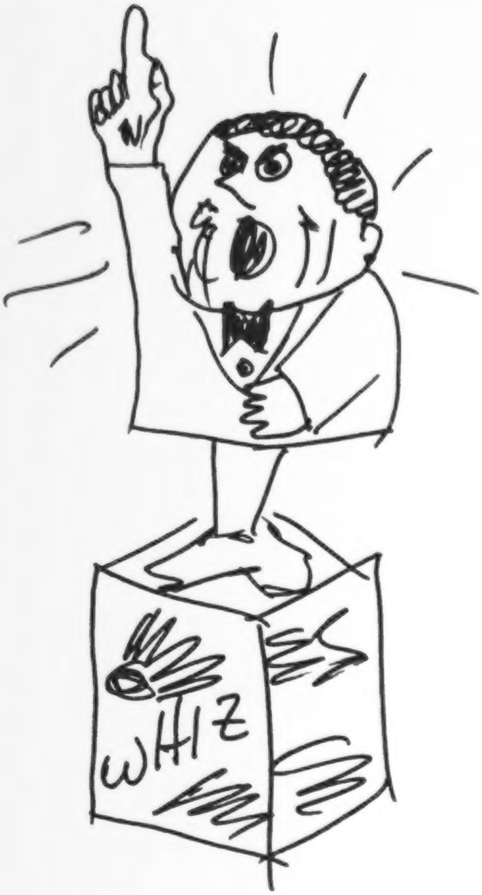
Obsolescence
(Prices—Very Low)

Functions of Advertising

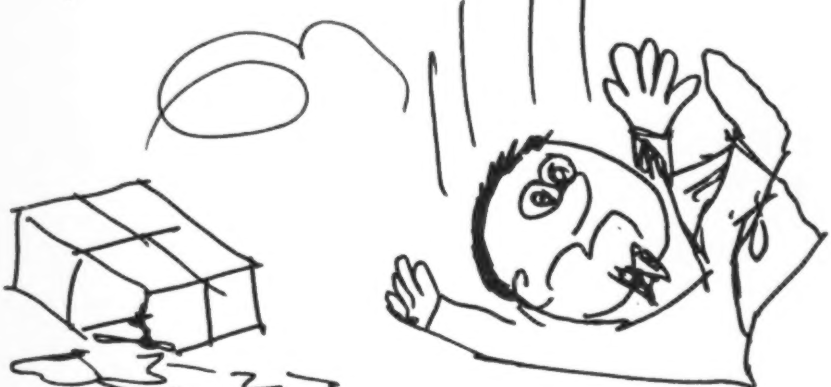

Company
Products

1. **Attract attention**
2. **Inform consumers about company and/or products**
3. **Persuade consumers**
4. **Initiate action**

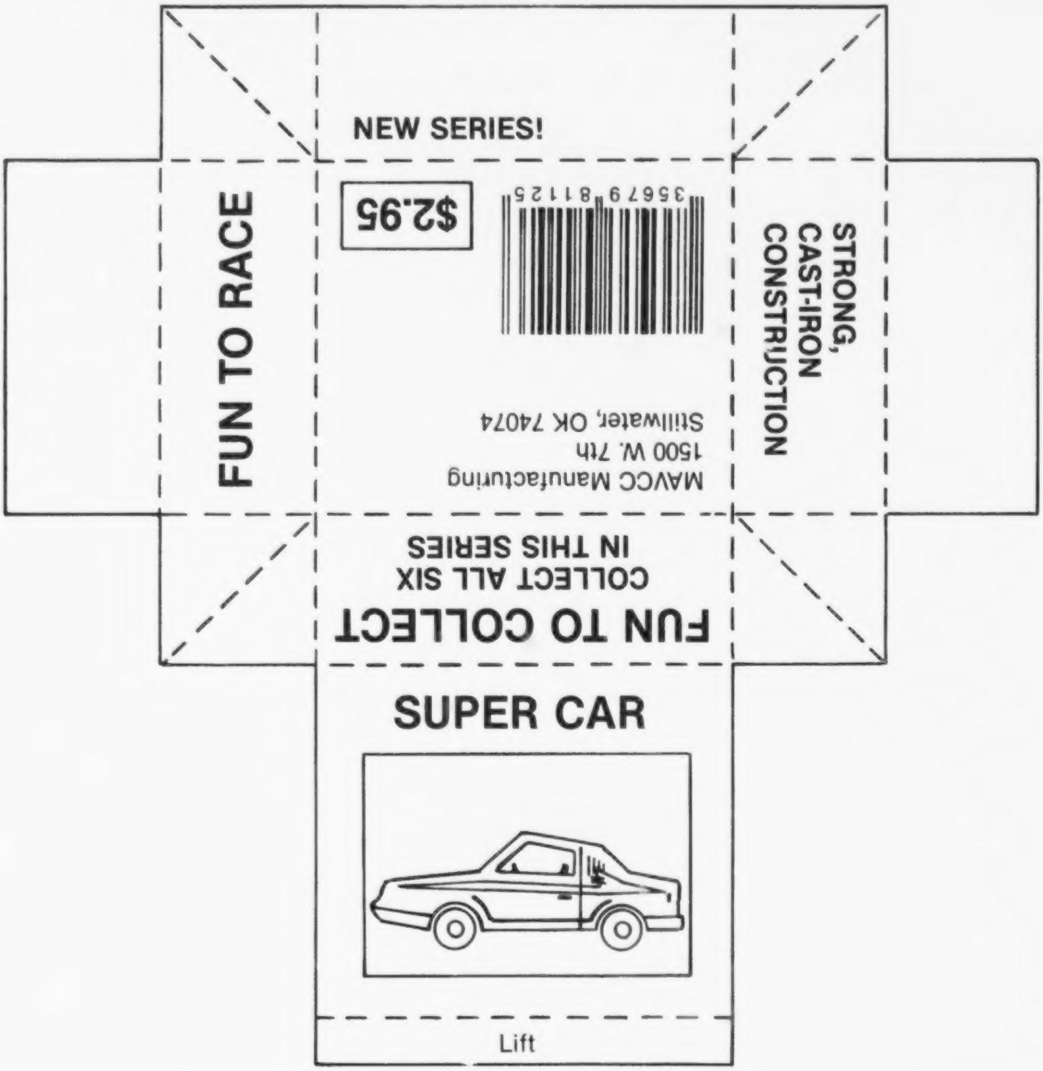
Functions of a Package



1. Promote the product
2. Provide information to the customer
3. Protect and hold the product



Items on a Package


NEW SERIES!
FUN TO RACE
$2.95
35679 81125
STRONG,
CAST-IRON
CONSTRUCTION
MAVCC Manufacturing
1500 W. 7th
Stillwater, OK 74074
FUN TO COLLECT
COLLECT ALL SIX
IN THIS SERIES
SUPER CAR
Lift

——— **Cut line**

– – – **Fold line**

Sales Activities

Sales Planning

Planning for the

RIGHT {
product
place
time
quantity
price

Sales Operations

- Knowing the product and the competition
- Understanding people and their wants and needs
- Experienced in the art of selling

Sample Sales Order Form

Sold to: #__________

____
Customer's Name

____
Customer's Address

Ship to:

____

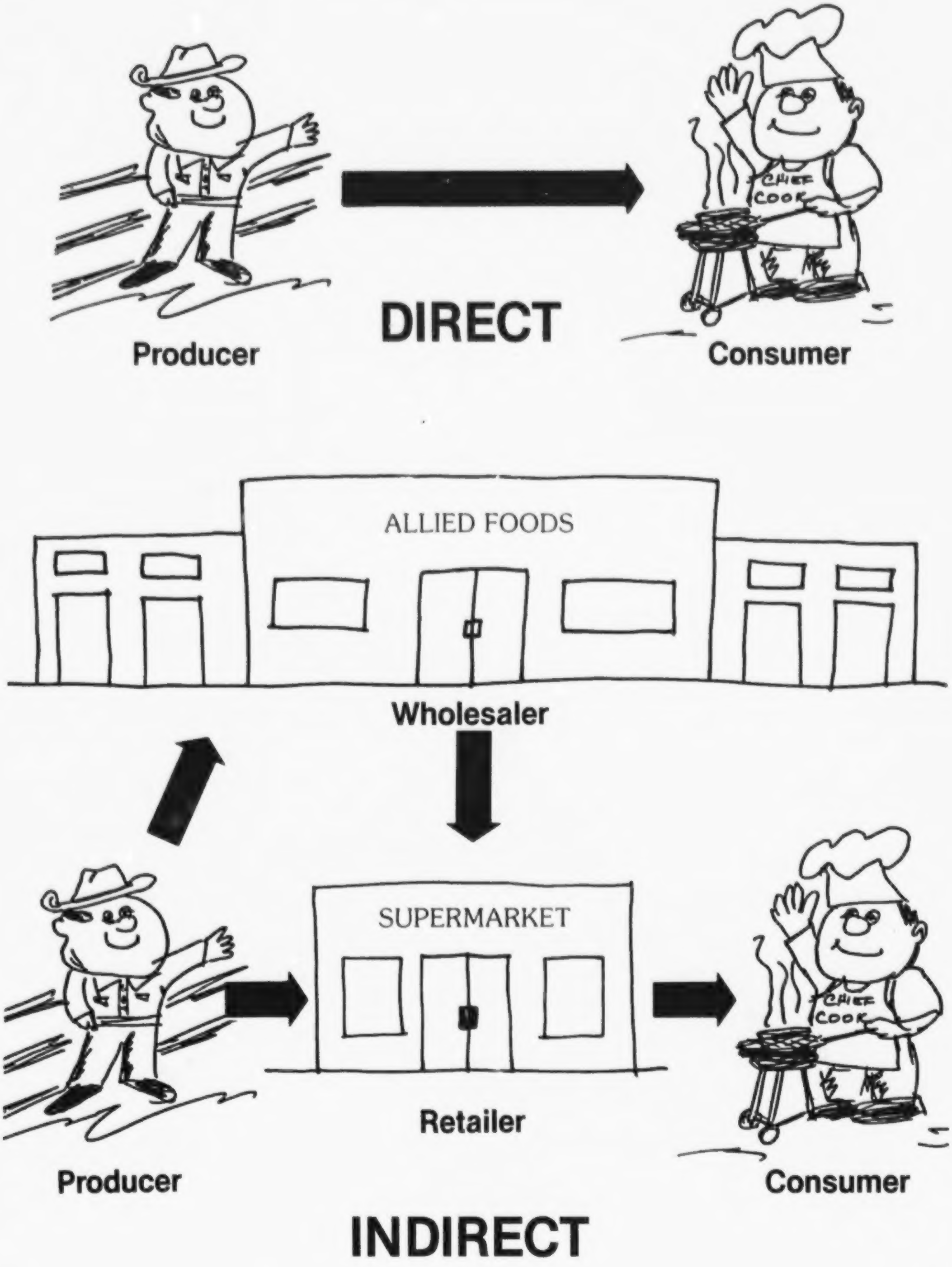
____

____

Quantity	Item Ordered	Unit Cost	Total Cost
			$
		+ S&H – Disc. + Tax	+ ______ – ______ + ______ $ ______

Terms of sale. . .

Methods of Distributing Goods


CHIEF COOK
Producer
DIRECT
Consumer
ALLIED FOODS
Wholesaler
SUPERMARKET
CHIEF COOK
Retailer
Producer
Consumer
INDIRECT

PRODUCT MARKETING
UNIT VII

ASSIGNMENT SHEET #1 — DESIGN AN ADVERTISEMENT TO PROMOTE AND SELL YOUR PRODUCT

NAME ____________________________ SCORE ______________________

Directions: Design a one-page advertisement ("flyer") for the product mass produced by your class or one selected by your instructor. The advertisement should fit on an 8½ × 11" sheet of paper and contain the elements necessary to sell the product.

Criteria:

1. Neatness
2. All information included
3. Attractive design
4. Appropriate size

PRODUCT MARKETING
UNIT VII

ASSIGNMENT SHEET #2 — DESIGN A PACKAGE FOR YOUR PRODUCT

NAME ____________________ SCORE ____________________

Directions: Design a package for the product you selected in an earlier assignment. The package layout should be sketched on a separate sheet of paper. Refer to Transparency 6 for an example.

The completed layout should be trimmed, folded, taped, and submitted for grading.

Criteria for grading include:

1. Neatness
2. All information included
3. Attractive design
4. Appropriate size

PRODUCT MARKETING
UNIT VII

TEST

NAME ______________________________ SCORE ______________

1. Match the terms on the right with their correct definitions.

_____a. Activities which determine the type, quality, and quantity of materials to be produced, and contributes to the sale of products to a consumer

_____b. One who sells goods directly to a consumer

_____c. One who purchases goods or services to satisfy needs, rather than to produce other goods

_____d. Products that last fewer than three years

_____e. A list of questions used with the public to determine the needs for or the probable acceptance of a product

_____f. Products that are expected to have a life of three or more years

_____g. A company's written guarantee regarding a product or service

_____h. One who sells goods in large quantities to a retailer

_____i. A series of vertical lines and spaces of varying widths and/or colors used to encode information, which can be read by a scanning device

_____j. A symbol or logo used by a company to identify their goods or services; usually legally registered and protected by law

1. Bar code
2. Consumer
3. Durable goods
4. Maintenance
5. Marketing
6. Market survey
7. Middleman
8. Non-durable goods
9. Retailer
10. Service
11. Trademark
12. Warranty
13. Wholesaler

TEST

2. Match major activities of marketing with their definition or description.

_____a. A careful study of the wants and needs of potential customers and their reactions to products

_____b. Communication aimed at motivating consumers to buy a product or service

_____c. Actual exchange of money for products

_____d. Containers used to hold products

_____e. Getting the product from the manufacturer to the customer

1. Advertising
2. Distribution
3. Packaging
4. Price
5. Market research
6. Sales
7. Service

3. Complete the following statements concerning elements of the marketing plan by placing answers in the appropriate blanks.

_____a. "Making consumers aware of products and its good features; typically done through advertising," is most closely associated with:
1) Distribution
2) Price
3) Product
4) Promotion
5) Service

_____b. Consumers must perceive the ____________ as a good "value" (good deal.)
1) Distribution
2) Price
3) Product
4) Promotion
5) Service

_____c. The element of the marketing plan which must meet the wants and needs of consumers is the:
1) Distribution
2) Price
3) Product
4) Promotion
5) Service

TEST

4. Select from the following list five purposes of market research by placing an "X" in appropriate blanks.

______a. When does the consumer attend school?

______b. Who is the consumer and where does she/he live?

______c. What does the consumer need and want?

______d. When do consumers like to shop?

______e. What products will the consumer buy?

______f. How much will the consumer pay for a product?

______g. How do people pay for products?

______h. How and where does the consumer buy a specific product?

5. Select from the following list three reasons for doing a market survey by placing an "X" in the appropriate blanks.

______a. Find out an individual's buying power

______b. Get reactions to a product

______c. Determine education of buyers

______d. Determine selling price of product

______e. Find out if people intend to buy product

6. Select from the following list the three main methods used to conduct market research by placing an "X" in the appropriate blanks.

______a. Personal contact

______b. Telephone

______c. Television

______d. Radio

______e. Mail

______f. Telegraph

TEST

7. Arrange the stages in a product's life cycle in order of occurrence by placing a "1" by the first stage, a "2" by the second stage, etc.

______a. Maturity

______b. Decline

______c. Growth

______d. Obsolescence

______e. Introduction

8. Select from the following list the functions of advertising by placing an "X" next to the appropriate statements.

______a. Initiate action to seek product

______b. Attract attention and make people want to see more

______c. Obtain information concerning potential buyers

______d. Determine product selling price

______e. Inform potential consumers about product features

______f. Persuade consumers to want to support idea or use product

9. Arrange in order the three basic steps in preparing an advertisement by placing a "1" by the first step, a "2" by the second step, etc.

______a. Design presentation

______b. Produce advertisement

______c. Develop message (idea people should receive)

10. Select from a list the principal elements of an advertisement and place an "X" in the appropriate blanks.

______a. Date product was first introduced

______b. Name of product's inventor

______c. Selling points and main features

______d. Attractive graphic representation or design

______e. Manufacturer's name

TEST

11. List five media used for advertisements.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

12. Select from a list the four major items in a profile of potential customers and place an "X" in the appropriate blanks.

_____a. Religion

_____b. Age range

_____c. Interest group (sports, teenagers, retirees, etc.)

_____d. Birthplace

_____e. Professional or non-professional status

_____f. Sex

13. Select from the following list the three main functions of a package by placing an "X" next to correct functions.

_____a. Protect and hold the product

_____b. Obtain information from consumer

_____c. Provide information to the consumer

_____d. Distribute the product

_____e. Promote the product

TEST

14. Match types of packaging and packaging processes on the right with the correct descriptions.

_____a. Plastic is stretched over product, heat is applied, and becomes smaller

_____b. A thermoformed plastic bubble of the basic shape of part to be packaged is made; product is placed inside bubble and then sealed to backing

_____c. Containers made of paper, fabric, or plastic with an opening in one end that can be closed

1. Bags
2. Blister packaging
3. Skin packaging
4. Shrink packaging
5. Cardboard packaging

15. Select from the following list the considerations in package selection. Place an "X" in the appropriate blanks.

_____a. Product

_____b. Laws

_____c. Market

_____d. Cost

_____e. Protection of the product

_____f. Consumer

16. Select from the following list the design considerations for packages. Place an "X" in the appropriate blanks.

_____a. Graphics of package

_____b. Acceptance of customers

_____c. Identification of product

_____d. Legal considerations

_____e. Inventory control information

TEST

17. Select from a list the items included in or on a package. Place an "X" in the appropriate blanks.

_____a. Instructions on how to open package

_____b. Bar code

_____c. Picture of the product

_____d. Storage system used

_____e. Repair instructions

_____f. Essential selling features

_____g. Distribution criteria

_____h. Manufacturer's name and address

_____i. Materials used in making product

_____j. Selling price

18. Distinguish between inventory and inventory control by placing an "X" next to inventory control.

_____a. The list of the amount of materials owned by a company

_____b. The method of keeping track of all materials used by a company

19. Select from the following list the categories of inventory by placing an "X" in the appropriate blanks.

_____a. Finished goods

_____b. Raw materials

_____c. Products shipped

_____d. Previous sales

_____e. Work in process

_____f. Purchased parts

TEST

20. Complete the following statements concerning status of products prior to distribution by placing the correct answers in the blanks.

_____a. Removing materials, parts, or assemblies from storage and putting it back in use or action is called:
1) Distribution
2) Delivery
3) Storage
4) Retrieval
5) Implementation

_____b. "Materials or products deposited in a safe place, usually temporary," describes:
1) Distribution
2) Delivery
3) Storage
4) Retrieval
5) Implementation

_____c. "The act of handing materials or products over," is called:
1) Distribution
2) Delivery
3) Storage
4) Retrieval
5) Implementation

21. Match the automated systems for storage, retrieval, and delivery with their correct descriptions.

_____a. Automatically retrieves and stores materials and products
_____b. Computerized materials inventory control, including ordering
_____c. Materials automatically ordered, and arrive as needed
_____d. Computer keeps track of parts and products as produced
_____e. Material moves throughout the plant automatically

1. CADD
2. CNC
3. AI
4. JIT
5. AGVS
6. ASRS
7. MRP

TEST

22. Select from a list the five important elements of sales planning. Place an "X" in appropriate blanks.

_____a. Product

_____b. Bar code

_____c. Place

_____d. Time

_____e. Graphics

_____f. Price

_____g. Quantity

23. Select from a list the five pieces of information a salesperson must know. Place an "X" in appropriate blanks.

_____a. The raw materials used

_____b. The purchased parts used in manufacturing

_____c. The art of selling

_____d. The customer

_____e. The competition

_____f. The product

_____g. The salesperson's job at the company

24. List the two major parts of a sales system.

a. ________________________________

b. ________________________________

TEST

25. Arrange in order the steps in a sales presentation by placing a "1" by step 1, a "2" by step 2, etc.

_____a. Make sales "pitch"

_____b. Follow-up the sale with reassurance, thanks, service

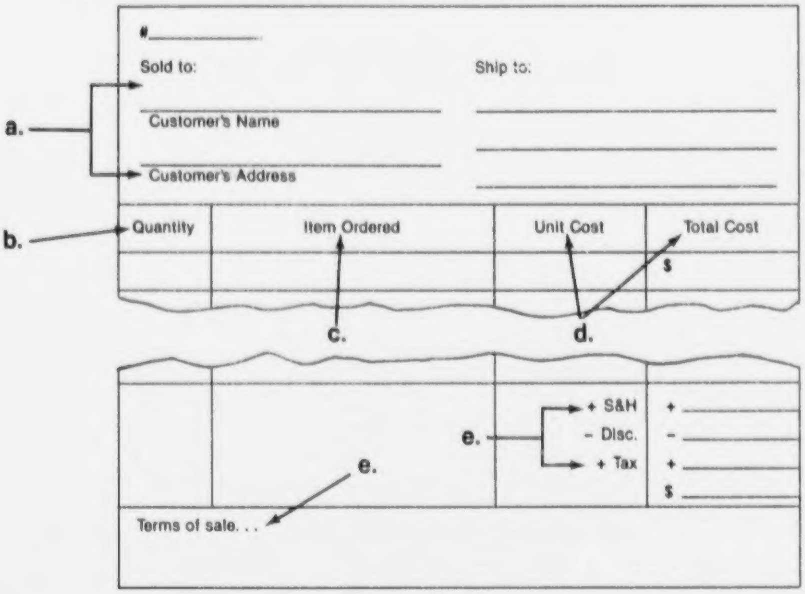
_____c. Answer customer's questions and objections to buying the product

_____d. Introduction of salesperson

_____e. Close the sale

_____f. Getting attention of customer

26. Identify the following parts of a sales order form.


#
Sold to:
Ship to:
a.
Customer's Name
Customer's Address
b.
Quantity
Item Ordered
Unit Cost
Total Cost
$
c.
d.
e.
+ S&H
− Disc.
+ Tax
+
−
+
$
e.
Terms of sale. . .

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

TEST

27. Distinguish between the two major methods of distributing goods by placing the following letters in the appropriate blanks.

D — Direct sales
I — Indirect sales

_____a. Manufacturers sell products to consumers

_____b. Examples are department stores

_____c. Examples are catalog sales and door-to-door sales of cosmetics

_____d. Manufacturers sell products to retailer or wholesaler, who then sells them to customers

28. List the two major ways to distribute and ship products.

a. ____

b. ____

29. Match the stages of the product use cycle with their descriptions or examples.

_____a. Results when product is worn out, too costly to repair

_____b. Examples are cleaning the heads in a VCR or changing oil in car

_____c. Example is hooking up a stereo system

_____d. Worn out or defective parts are fixed or replaced

1. Install
2. Retrieve
3. Maintain
4. Repair
5. Distribute
6. Replace

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

30. Design an advertisement to promote and sell your product. (Assignment Sheet #1)

31. Design a package for your product. (Assignment Sheet #2)

PRODUCT MARKETING
UNIT VII

ANSWERS TO TEST

1. a. 5
b. 9
c. 2
d. 8
e. 6
f. 3
g. 12
h. 13
i. 1
j. 11

2. a. 5
b. 1
c. 6
d. 3
e. 2

3. a. 4
b. 2
c. 3

4. b, c, e, f, h

5. b, d, e

6. a, b, e

7. a. 3
b. 4
c. 2
d. 5
e. 1

8. a, b, e, f

9. a. 2
b. 3
c. 1

10. c, d, e

ANSWERS TO TEST

11. Any five of the following:

    a. Letters
    b. Catalogs
    c. Magazines and journals
    d. Newspapers
    e. Radio
    f. Television
    g. Billboards
    h. Package

12. b, c, e, f

13. a, c, e

14. a. 4
    b. 2
    c. 1

15. a, b, c, d, e, f

16. a, b, c

17. a, b, c, f, h, i, j

18. b

19. a, b, e, f

20. a. 4
    b. 3
    c. 2

21. a. 6
    b. 7
    c. 4
    d. 3
    e. 5

ANSWERS TO TEST

22. a, c, d, f, g

23. c, d, e, f, g

24. a. Sales presentation
    b. System for recording sale

25. a. 3 d. 1
    b. 6 e. 5
    c. 4 f. 2

26. a. Customer's name/address
    b. Quantity ordered
    c. Item ordered
    d. Cost
    e. Additional information

27. a. D
    b. I
    c. D
    d. I

28. a. Mail delivery
    b. Transport system — air, rail, truck

29. a. 6
    b. 3
    c. 1
    d. 4

30.-31. Evaluated to the satisfaction of the instructor

EVALUATION AND DISSOLUTION OF THE ENTERPRISE

UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to dissolve and evaluate their student enterprise. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to evaluation and dissolution of the enterprise with the correct definitions.
2. Select from a list the characteristics of successful companies.
3. Select from a list the characteristics of successful people.
4. Match records and reports for calculating a company's profit and loss with the correct descriptions.
5. Select from a list the definition of dissolution.
6. List the two types of dissolution.
7. Complete statements concerning voluntary dissolution.
8. Complete statements concerning involuntary dissolution.
9. Complete statements concerning the steps in dissolving a corporation.
10. Complete statements pertaining to evaluating a student enterprise and the personnel.

OBJECTIVE SHEET

11. Complete a "Corporation Dissolution" terminology crossword puzzle. (Assignment Sheet #1)
12. Dissolve the simulated enterprise and complete Articles of Dissolution. (Assignment Sheet #2)
13. Evaluate your enterprise and yourself. (Assignment Sheet #3)

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

(NOTE: You may also wish to provide your students with the word list that corresponds to the crossword puzzle on Assignment Sheet #1. This list is included with the answers to that assignment sheet.)

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Have students discuss how they define success, what makes a person successful, and examples of successful people.
2. Show examples of actual records used to calculate a company's profit and loss.
3. Discuss local companies that have recently dissolved and why they are no longer in business (voluntary or involuntary).
4. Have students discuss what they have learned from the student enterprise, what they liked/disliked, and what they would do differently next time.
5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN DEVELOPING THIS UNIT

A. Fales, James, et. al. *Manufacturing: A Basic Text*, 2nd ed. Encino, CA: Glencoe Publishing Co., 1986.

B. Jambro, Thomas. *Introduction to Manufacturing*. Albany, NY: Delmar Publishers Inc., 1982.

C. Wright, R. Thomas. *Exploring Manufacturing*. South Holland, IL: Goodheart-Willcox Co., 1985.

D. Wright, R. Thomas. *Manufacturing—Material Processing, Management, Careers*. South Holland, IL: Goodheart-Wilcox Co., 1984.

E. Wright, R. Thomas and Len Sterry. *Industry and Technology Education: A Guide for Curriculum Designers, Implementors, and Teachers*. Lansing, IL: Technical Foundation of America, no date.

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

INFORMATION SHEET

I. **Terms and definitions** (Assignment Sheet #1)

A. Annual sale — A sale performed once a year to liquidate assets

B. Assets — Valuable items that are owned

C. Bankruptcy — A procedure whereby an individual's or company's assets are taken and distributed for the benefit of creditors, and the debtor is released from all existing debts

D. Capitalism — An economic system based on free enterprise, with increasing private or corporate ownership, proportionate to the accumulation and reinvestment of profits

E. Court order — Legal act of the court, initiated by a creditor, stockholder, or someone filing suit (suing)

F. Creditor — A person or firm to whom money or equivalent is owed

G. Dividend — A share of profits received by a stockholder or investor

H. Economy — The management of the resources of a government, community, business, or individual

I. Evaluation — The process of examining and judging

J. Foreclosure — The act of depriving a debtor of the right to redeem mortgaged property, as when he/she has failed to make payments

K. Gross profit — The total income of a person or a business

L. Income — The amount of money earned during a period of time in exchange for labor or services rendered

M. Liabilities — An obligation or debt for which a person or company is responsible

N. Liquidation — To legally "kill" a company; all products and materials are sold

O. Loss — The monies that are not recovered on an investment after all operating expenses have been met

P. Net profit — The total income of a person or business after all operating expenses are deducted

INFORMATION SHEET

Q. Net worth — The value of a person or a company remaining after all liabilities are subtracted from assets

R. Productivity — The speed and accuracy at which an employee works and/or products are made; calculated by the amount of work (output of product) divided by hours worked

$$\frac{\text{Products}}{\text{Workhours}} = \text{Productivity}$$

S. Profit — The return on an investment after all operating expenses have been met

T. Revenue — Yield from property or investment

II. **Characteristics of successful companies**

A. Have good organization

B. Reward owners for investing in the company

C. Have high productivity

D. Develop new products and technology

E. Replace equipment as needed

F. Invest in other businesses

G. Manage well so that workers and owners receive their fair share

H. Consider society's goals

I. Devise successful marketing strategies

J. Pay workers fair wages

K. Provide steady employment

L. Give opportunities for advancement within the enterprise

M. Make working conditions as pleasant and safe as possible

N. Hire successful people

INFORMATION SHEET

III. Characteristics of successful people

(NOTE: There are many reasons given as to why some people are successful and some people are failures. The studies made of successful people have found that motivation for success is more important than intelligence or education. These studies also identified several characteristics the successful people have in common.)

A. Believe in yourself.

B. Set goals and objectives.

C. Practice self discipline.

D. Work hard.

E. Learn and improve skills constantly.

F. Get along with other people.

G. Have the courage to act and make decisions.

IV. Records and reports for calculating a company's profit and loss done by financial accounting

A. Balance sheet — Financial sheet that shows a company's

   1. Assets
   2. Liabilities
   3. Net worth

B. Profit and loss statement (income statement)

   1. A report issued monthly, quarterly, or at end of year.
   2. The net figure represents the profit or loss of the company for the period.
   3. Shows profits per share of stock.
   4. Shows revenues, expenses, taxes, and net income.

C. Manufacturing cost statement

   1. A further breakdown of the profits and loss statement
   2. Includes material expenses, labor expenses, manufacturing expenses, and status of products

INFORMATION SHEET

D. Annual report — A report, usually in booklet or magazine form, sent to stockholders to let them know the activities (gains, developments, etc.) of the company for the previous year.

V. **Definition of dissolution** — The legal process which puts a corporation out of business

(NOTE: All corporations, including the one formed by your class, must remain active to stay alive. When a corporation has no products to develop, produce, or market, the corporation is "dead." More than 400,000 corporations in the United States go out of business every year. After the dissolution process, all of the corporation's activities stop and the corporation ceases to exist.)

VI. **Types of dissolution** (Transparency 1)

A. Voluntary dissolution

B. Involuntary dissolution

VII. **Voluntary dissolution**

A. A corporation can be dissolved because the owners choose to go out of business.

B. The most common reasons for dissolution of a corporation are insufficient profits or dissatisfaction of the owners.

C. The stockholders of a corporation must meet and vote to dissolve the corporation. This meeting is called by the board of directors or by the stockholders themselves.

VIII. **Involuntary dissolution**

A. Corporations can be dissolved by people outside the corporation either by court order or by a state regulatory agency decision.

B. There are three major reasons that cause corporations to be dissolved involuntarily:

1. *Bankruptcy*. The courts can dissolve a corporation if it is unable to pay its debts.
2. *Improper activities*. The courts can dissolve a corporation if it is operating illegally or is involved in fraud (dishonest financial activities).
3. *Failure to meet state requirements*. An agency of the state can revoke a corporation's charter if it does not pay its taxes, does not file the proper reports, or fails to carry out the purposes stated in its charter.

INFORMATION SHEET

IX. **Steps in dissolving a corporation** (Assignment Sheet #2)

A. File the proper legal documents.

B. Terminate the employees.

C. Convert all assets into cash.

D. Distribute the cash. Debts are paid off in the following order (listed from first to last). (Transparency 2)

1. Taxes
2. Legal fees
3. Employee wages and salaries
4. Creditors
5. Stockholders/owners

(NOTE: After these steps have been performed, the corporation loses its status as an entity; that is, it no longer legally exists.)

X. **Areas for evaluating a student enterprise and the personnel** (Assignment Sheet #3)

A. Evaluation of student enterprise

1. Organization of company
2. Production of products
3. Marketing of products

B. Evaluation of personnel

1. Attitudes
2. Productivity

Corporation Dissolution

Voluntary

Articles of Dissolution

because

1. Insufficient Profits
2. Unhappy Owners

Involuntary

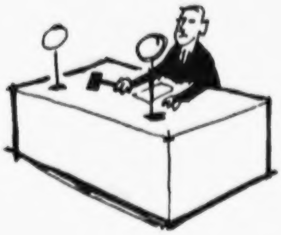
Court Order

because

1. Bankruptcy
2. Improper Activities
3. Failure to Meet State Requirements

Distribution of Cash

1. Taxes



2. Legal Fees

3. Employee Salaries

LOAN
BILL
Bill
BILL

4. Creditors

5. Stockholders

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

ASSIGNMENT SHEET #1 — COMPLETE A "CORPORATION DISSOLUTION" TERMINOLOGY CROSSWORD PUZZLE

NAME ______________________ SCORE ____________________

Directions: This crossword puzzle reviews some of the terminology discussed in this unit. Carefully review the clues and fill in the appropriate blanks. This activity should be done in *pencil*.

ASSIGNMENT SHEET #1

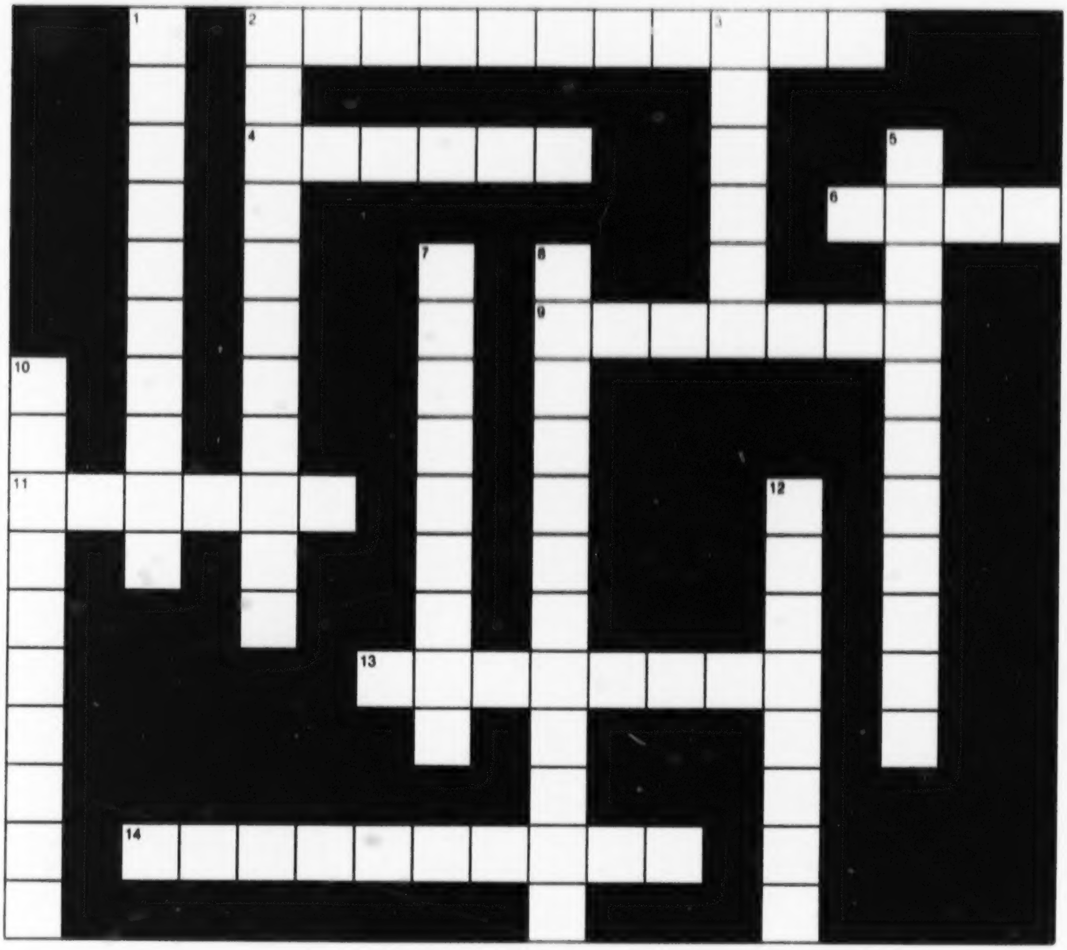
ACROSS CLUES

2. To legally "kill" a company; all products and materials are sold
4. Valuable items that are owned
6. The monies that are not recovered on an investment after all operating expenses are met
9. Yield from property or investment
11. The return on an investment after all operating expenses have been met
13. A share of profits received by a stockholder or investor
14. A procedure whereby an individual's or a company's assets are taken and distributed; the debtor is released from debt

DOWN CLUES

1. The process of examining and studying
2. An obligation or debt for which a person or company is responsible
3. The amount of money earned during a period of time in exchange for labor or services rendered
5. The act of depriving a debtor of the right to redeem mortgaged property
7. The total income of a person or business after all operating expenses are deducted
8. The speed and accuracy at which an employee works and/or products are made
10. An economic system based on free enterprise
12. A person or firm to whom money or equivalent is owed

ASSIGNMENT SHEET #1


1
2
3
4
5
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7
8
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10
11
12
13
14

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

ASSIGNMENT SHEET #2 — DISSOLVE THE SIMULATED ENTERPRISE AND COMPLETE ARTICLES OF DISSOLUTION

NAME ____________________ SCORE ____________________

Directions: Use the following procedure to dissolve your corporation. Perform specific tasks as they apply to your position in the corporation.

1. The president determines that the books are balanced.
2. The vice-president of finance reports the financial condition of the corporation to the board of directors.
3. The president recommends to the board that the corporation be dissolved.
4. A meeting of the stockholders (class) is called and a vote to dissolve is taken.
5. Articles of Dissolution (which follow) are prepared and submitted to the authority issuing the corporation charter.
6. Employees are notified of their termination.
7. All assets are converted into cash.
8. All bills are properly paid.
9. The entries are made into the balance sheet and the dividend per share is calculated.
10. The balance sheet is explained to the stockholders (class) and a check is written for each shareholder.
11. Shares are exhanged for the dividend checks.
12. The corporation charter is returned to the issuing authority.
13. The corporation is now officially dissolved.

ASSIGNMENT SHEET #2

ARTICLES OF DISSOLUTION

TO THE SECRETARY OF STATE OF THE STATE OF ____________________

The undersigned Corporation, for the purpose of dissolving said Corporation pursuant to the unanimous consent of its shareholders under Section _____ of the "Business Corporation Act" of the State of ___________, hereby executes the following Articles of Dissolution.

ARTICLE I: The name of the Corporation is ______________________________.

ARTICLE II: The address of its Registered Office is ____________________, ____________________, ____________________; and the name and address of its Registered Agent is ______________________________.

ARTICLE III: The date of issuance of its Certificate of Incorporation was ____________________, 19_____, and its period of existence specified in its Articles of Incorporation is ______________.

ARTICLE IV: The names and respective addresses of its principal officers, including its Directors are:

NAME	ADDRESS

ARTICLE V: All debts, liabilities, and obligations of the Corporation have been paid and discharged, or adequate provisions have been made therefor, and all of its remaining property and assets have been distributed to its shareholders.

ARTICLE VI: The Corporation intends to dissolve and the written consent of the registered holders of all of its shares has been filed with the Secretary of this Corporation.

Dated this ______________ day of ______________________, 19_______.

By ______________________________

(SEAL)

ATTEST: ______________________________

STATE OF ______________________)
) SS
COUNTY OF ______________________)

Subscribed and swore to before me this _________ day of ______________, 19_____.

____
NOTARY PUBLIC

____
date my commission expires

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

ASSIGNMENT SHEET #3 — EVALUATE YOUR ENTERPRISE AND YOURSELF

NAME ______________________________ SCORE ______________________

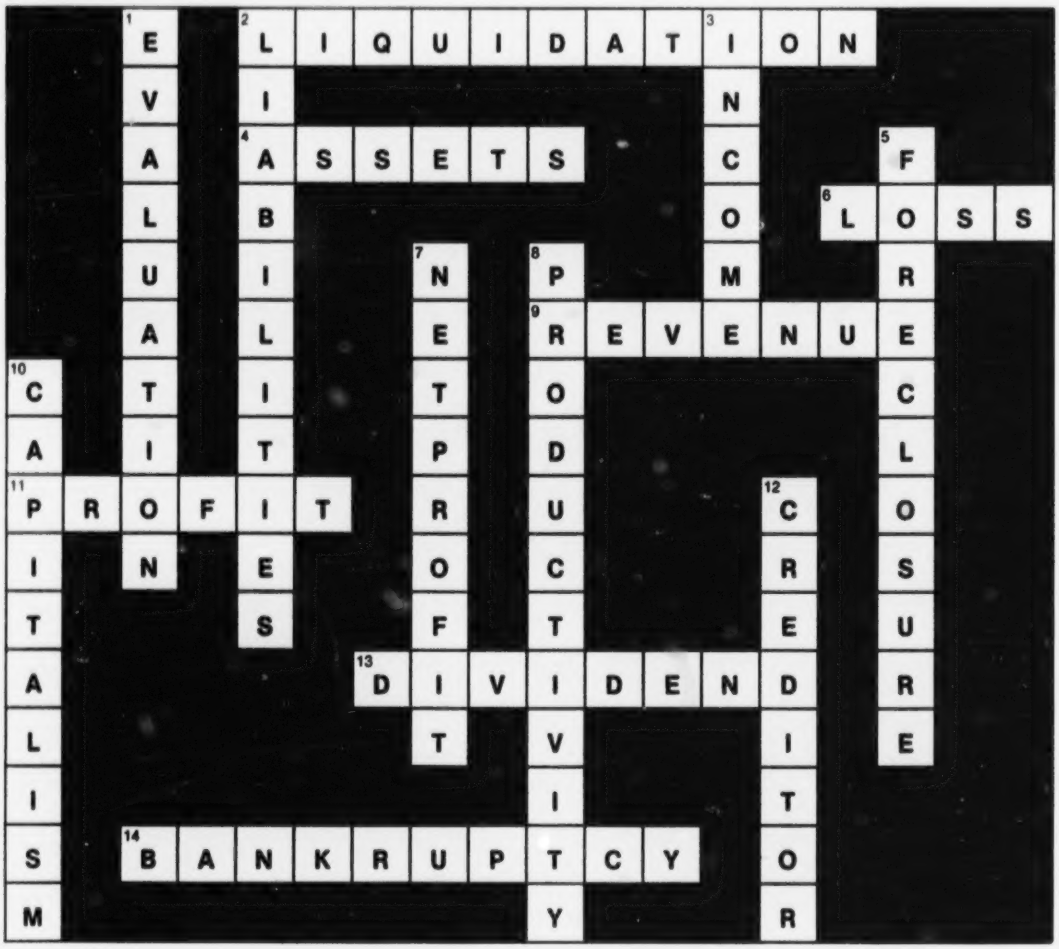
Directions: Rate your enterprise and yourself using a scale of 1 to 5 with 5 as the highest in the following areas:

	Rating 1 to 5
A. Enterprise	
1. Organization	____________
2. Production of products (quality and quantity)	____________
3. Marketing of products	____________
B. Personnel (workers)	
1. Attitudes	____________
2. Productivity	____________
	______________
Total =	____________

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


1 EVALUATION
2 LIQUIDATION
2 LIABILITIES
3 INCOME
4 ASSETS
5 FORECLOSURE
6 LOSS
7 NETPROFIT
8 PRODUCTIVITY
9 REVENUE
10 CAPITALISM
11 PROFIT
12 CREDITOR
13 DIVIDEND
14 BANKRUPTCY

WORD LIST:

Assets
Bankruptcy
Capitalism
Creditor
Dividend
Evaluation
Foreclosure
Income
Liquidation
Liabilities
Loss
Netprofit
Profit
Productivity
Revenue

Assignment Sheets #2-#3 — Evaluated to the satisfaction of the instructor

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

TEST

NAME ______________________________ SCORE ______________

1. Match the terms on the right with the correct definitions on the left.

______a. To legally "kill" a company; all products and materials are sold

______b. The total income of a business after all operating expenses are deducted

______c. Yield from property or an investment

______d. The value of a company remaining after all liabilities are subtracted from assets

______e. The return on investment after all operating expenses have been met

______f. An obligation or debt for which a person or company is responsible

______g. The act of depriving a debtor of the right to redeem mortgaged property, as when he/she has failed to make payments

______h. The process of examining and judging

______i. A share of profits received by a stockholder or investor

1. Assets
2. Dividend
3. Evaluation
4. Foreclosure
5. Liabilities
6. Liquidation
7. Net profit
8. Net worth
9. Profit
10. Revenue

2. Select from the following list the characteristics of successful companies by marking an "X" next to correct responses, and an "O" next to those that do not apply.

______a. Have good organization

______b. Hire successful people

______c. Exploit the workers

______d. Reward owners for investing in the company

______e. Ignore working conditions

______f. Have high productivity

______g. Lay people off

TEST

_____h. Make working conditions as safe and pleasant as possible

_____i. Give opportunities for advancement within the enterprise

_____j. Have scheduled periodic lay-offs

_____k. Disregard society's needs

_____l. Invest in other businesses

_____m. Provide steady employment

3. Select from the following list the characteristics of successful people by marking an "X" next to correct responses, and an "O" next to those that don't apply.

_____a. Ignore other people

_____b. Work hard

_____c. Believe in themselves

_____d. Are unmotivated

_____e. Are decisive

_____f. Set goals and objectives

_____g. Rest on their laurels

_____h. Are selfish

_____i. Quit after failure

_____j. Get along with others

4. Match records and reports for calculating a company's profit and loss on the right with the correct descriptions.

_____a. A further breakdown of the income statement that includes material expenses, etc.

_____b. Financial statement that shows a company's assets, liabilities, and net worth

_____c. A report sent to stockholders to inform them of company activities for the previous year

_____d. A report issued periodically that shows a company's profit or loss, profit per share of stock, revenues, expenses, taxes, and net income for a stated period

1. Balance sheet
2. Profit and loss statement
3. Manufacturing cost statement
4. Annual report

TEST

5. Select the best definition of dissolutions below with an "X".

______a. A financial sheet that shows assets

______b. The legal process which puts a corporation out a business

______c. A process where all products and materials are sold

______d. A procedure where assets are distributed for the benefit of creditors, and the debtor is released from all debts

6. List two types of dissolution.

a. ____

b. ____

7. Complete statements concerning voluntary dissolution by circling the best answers.

a. A corporation can be voluntarily dissolved because the owners (**choose, are forced**) to go out of business.

b. The most common reasons for dissolution of a corporation or business are (**excessive, insufficient**) profits or (**satisfaction, dissatisfaction**) of the owners.

c. The (**stockholders, employees**) of a corporation must meet and vote to dissolve the corporation.

8. Complete statements concerning involuntary dissolution by circling the best answers.

a. Corporations can be dissolved by people outside the corporation by either a court order or by a (**federal, state**) agency decision.

b. The three major reasons that cause corporations to be dissolved are failure to meet state requirements, improper activities, and (**foreclosure, bankruptcy**).

9. Select the steps for dissolving a corporation by placing an "X" next to correct responses, and an "O" next to incorrect ones.

______a. File the proper legal documents.

______b. File for bankruptcy.

______c. Aid in foreclosure.

______d. Convert all assets into cash.

______e. Distribute the cash.

______f. Terminate the employees.

TEST

10. Complete the statements pertaining to evaluating the student enterprise and the personnel by marking an "X" next to correct responses and an "O" next to incorrect responses.

    a. The evaluation of a student enterprise should include:

    ______1.) Organization of company
    ______2.) Production of products
    ______3.) Sales
    ______4.) Attitudes
    ______5.) Productivity
    ______6.) Marketing of products

    b. The evaluation of personnel should include:

    ______1.) Organization of company
    ______2.) Production of products
    ______3.) Sales
    ______4.) Attitudes
    ______5.) Productivity
    ______6.) Marketing of products

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

11. Complete a "Corporation Dissolution" terminology crossword puzzle. (Assignment Sheet #1)

12. Dissolve the simulated enterprise and complete Articles of Dissolution. (Assignment Sheet #2)

13. Evaluate your enterprise and yourself. (Assignment Sheet #3)

EVALUATION AND DISSOLUTION OF THE ENTERPRISE
UNIT VIII

ANSWERS TO TEST

1. a. 6
   b. 7
   c. 10
   d. 8
   e. 9
   f. 5
   g. 4
   h. 3
   i. 2

2. a. X
   b. X
   c. O
   d. X
   e. O
   f. X
   g. O
   h. X
   i. X
   j. O
   k. O
   l. X
   m. X

3. a. O
   b. X
   c. X
   d. O
   e. X
   f. X
   g. O
   h. O
   i. O
   j. X

4. a. 3
   b. 1
   c. 4
   d. 2

5. b

6. a. Voluntary
   b. Involuntary

7. a. Choose
   b. Insufficient, dissatisfaction
   c. Stockholders

ANSWERS TO TEST

8. a. State
   b. Bankruptcy

9. a. X
   b. O
   c. O
   d. X
   e. X
   f. X

10. a.
    1) X
    2) X
    3) O
    4) O
    5) O
    6) X

    b.
    1) O
    2) O
    3) O
    4) X
    5) X
    6) O

11.-13. Evaluated to the satisfaction of the instructor